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VOL. VII APRIL, 1953 NO. 2

PACIFIC SCIENCE

A QUARTERLY DEVOTED TO THE BIOLOGICAL AND PHYSICAL SCIENCES OF THE PACIFIC REGION

IN THIS ISSUE: Yamamoto—*Rotatorian Fauna of Korea* ● St. John and Mason—*Vernacular Names of Plants of Bikini* ● Landa—*Body Length to Scale Length in the Pacific Pilchard* ● Vandel—*A New Isopod from Oregon* ● Li—*Plant Interchanges between Formosa and the Philippines* ● Levi-Castillo—*Culex* (Phalangomyia) *in Ecuador* ● Parrott—*Catalogue of Australian Braconidae* ● Harry—*Bathypelagic Fishes, Paralepididae* ● NOTES

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(Continued on inside back cover)

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Preliminary Studies on the Rotatorian Fauna of Korea[1]

KOKICHI YAMAMOTO[2]

INTRODUCTION

THOROUGH LIMNOLOGICAL SURVEYS in Korea have not been carried out up to the present time; only a few brief studies on the plankton, especially on the rotatorian fauna, have been made in several districts. There are papers relating to the Korean rotatorians published by five authors, namely, Kawamura (1917), Hada (1936), Ueno (1941), Sato (1939, 1941), and Yamamoto (1941). One of the reasons why such studies have been neglected is the paucity of lakes and ponds suitable for collections, except for a series of brackish-water lakes on the coast of the Japan Sea and reservoirs recently built for hydroelectric plants. The studies of the fresh-water fauna of Korea are quite incomplete when compared with those made on the fauna of Manchuria, which has been clarified by several researches under the direction of Professor T. Kawamura and summarized by Yamasaki (1940).

The author, accompanied by M. Ueno, made a trip for limnological work to the middle, eastern, and western districts of Korea from November 19 to 26, 1941. Since returning to the laboratory the author has engaged in a microscopical study of the rotatorians in the plankton obtained. At the same time, collections made by us in the preceding year in the northern part of Korea, as well as materials preserved in our laboratory, were examined. These latter consist of specimens which were collected by T. Kawamura during June, 1936, and by A. Tanaka in Lake Puchonho in 1931.

Through the courtesy of T. Kamita of Keijo Normal School, some plankton samples collected by T. Sato in the City of Keijo (Seoul) and the neighborhood were placed at my disposal for study. The rotatorians found in all these collections are reported upon in the following pages. Previous records are included in the list.

As the specimens treated here have been collected not only in a limited season but also from comparatively confined localities, they are not sufficient basis for a full discussion of the rotatorian fauna of Korea. The survey was to include different seasons and additional various localities, but the program was of necessity changed by the outbreak of war. Difficulties of travel had increased day by day, and finally the war made continuation of our survey in this peninsula impossible. Therefore, this report is based on limited material.

I wish to express my thanks to Doctor Ueno for his kind advice during the journey and in the research room.

LOCALITIES

The specimens examined were obtained from 16 bodies of water, which included all localities from which there are previous records. They are placed in four regions—northern, middle, eastern, and western—no collections having been made in the southern portion of the peninsula. The stations are shown on the sketch map in Figure 1. Table 1 shows some ecological data for the stations examined by Ueno and Yamamoto; such data

[1] Contribution No. 133 from the Otsu Hydrobiological Station of the University of Kyoto.

[2] Otsu Hydrobiological Station, University of Kyoto. Manuscript received March 23, 1949.

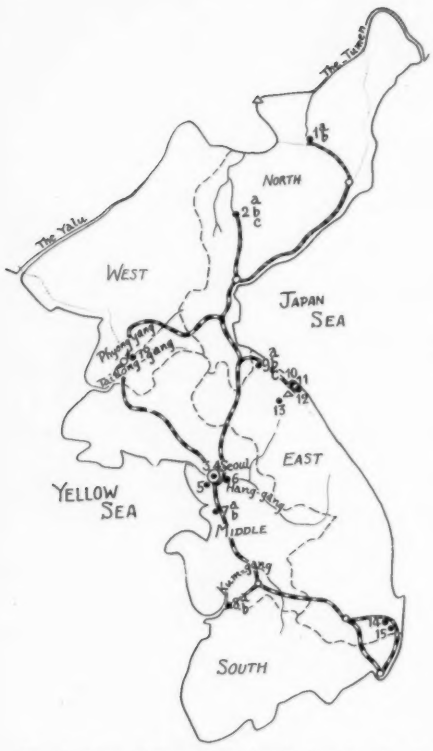

Fig. 1. Map of Korean Peninsula showing the five main regions and the collection localities (1–16). (Heavy broken line indicates railways.)

are unavailable for the earlier collections by Tanaka, Kawamura, and Sato.

1. Daitaku (cf. Ueno, 1941) (Tai-taik).

This is a bog lake situated in the moorland of the Paik-mo high plateau, Ham-Gyon Puk Do. Pelagic (station 1*a*) and littoral (1*b*) plankton were collected. Some microorganisms were also obtained among the mosses of the surrounding swamp.

2. Lake Fusenko (cf. Ueno, 1941) (Puchon-ho).

This is a gigantic reservoir for the hydroelectric plant which has dammed the river Puchon-gang, an upper tributary of the river Yalu. The collections by A. Tanaka (2*b*) from this lake were obtained during its early stages as a lake.

3. A small pond at Shochudan in Seoul.
4. A small pool at Shindocho in Seoul.
5. Eitoho, southwestern suburb of Seoul.
6. River Kan-ko (the Hang-gang).

The potamoplankton was collected on the river in cross section at Tokuson, southeastern suburb of Seoul.

7. Seiko or West Lake, south of Seoul.

One of the collections examined was made by T. Kawamura (7*a*) 5 years before our visit (7*b*). This lake was built artificially about 300 years ago at the foot of Mt. Reiki, imitating the site of Si-hu in Hangchow, China.

8. Kanggyong.

Station 8*a* is a pond with luxuriant growth of water weeds among rice fields. Its surface area is about 100 square meters.

Station 8*b* is an oxbow lake on the meandering lower reaches of the river Kum-gang.

9. Lake Kodoho (Kangdong-po).

This brackish lake of medium area is situated near the coast of the Japan Sea. The collections were done at three stations, one being the center of the lake (9*a*), the next (9*b*) near "Jichudai," an island situated south of the center, and the last (9*c*) in the southern basin.

10. A pond near the Sanjippo railway station.

On the east of the railway station there is a small pond with clear water in an area surrounded by granite rocks.

11. Lake Sanjippo (Sam-il-po).

This lake is also situated in the granite area and has very clear water. The collection was made by using a boat at the southern extremity of the lake.

12. Lake Kanko (Kam-ho).

This is a small pond which is situated among pine forests on the coast of the Japan Sea.

13. Inner Diamond Mountain (Kumgang san).

The plankton was collected by Kawamura from the small pond of the Choanji Temple.

14. Gan-o-chi.

This small pond of badly contaminated water is historically famous. It is said that this pond was built nearly 2,000 years ago in

TABLE 1
ECOLOGICAL DATA AT VARIOUS COLLECTION STATIONS IN KOREA

STATION NUMBER	REGION	HOUR	DATE	AIR TEMP.	WATER TEMP.	*p*H	R*p*H	PER CENT CL
				°C.	°C.			
1(*a*,*b*)	N	14	15 VII 1940	21.0	19.5	6.3	6.1	.....
2*a*	N	10	11 VII 1940	.....	21.0	6.8	.....	.....
6	M	10	22 XI 1941	11.2	9.8	7.4	7.3	.....
7*b*	M	14	9 XI 1941	17.6	12.7	6.6	6.7	.....
8*a*	M	13	24 XI 1941	13.0	11.4	8.6	8.2	.....
8*b*	M	14	24 XI 1941	11.9	11.8	7.8	7.8	0.08
9*a*	E	14	14 XI 1941	15.8	12.0	7.7	7.3	.....
9*b*	E	.....	14 XI 1941	.....	.....	7.9	7.6	.....
9*c*	E	16	14 XI 1941	.....	12.4	8.6	8.6	0.97
10	E	9	12 XI 1941	9.8	9.2	6.3	6.3	.....
11	E	10	12 XI 1941	15.0	11.5	6.5	6.4	.....
12	E	15	12 XI 1941	15.5	15.8	7.0	7.2	.....
14	E	10	27 XI 1941	9.8	8.7	6.8	6.9	.....
15	E	9	26 XI 1941	5.9	9.2	6.9	7.0	.....
16	W	14	17 XI 1941	18.5	11.7	7.7	7.4	0.02

the garden of the Royal Palace in Keishu (Kyongju).

15. A pond west of the Bukkokuji railway station.

Two kinds of collections were made, one from near the surface (15*a*) and the other from the bottom (15*b*).

16. River Taidong-gang at Phongyang.

The potamoplankton was collected on the river near Hangetsu-to (Halfmoon Island) in 5 minutes' upstream sailing.

SPECIES FOUND IN PRESENT MATERIAL

As the result of research on the materials from the stations mentioned above, 73 species (including 8 varieties and 7 forms) belonging to 10 families and 26 genera have been identified. Besides these there were several species impossible to identify because of the strong contraction of the body. Seven species, which appeared in the previous records, could not be found in the present examination. Thus, at present 83 species are known to occur in Korea. Although this is not a large number of species, it compares well with the number recorded from Japan.

In the following list the distribution within Korea is indicated by region and station. The known distribution in other parts of the Far East is also given. Species marked with an asterisk are not present in the material studied.

Order FLOSCULARIACEA
Family CONOCHILIDAE

1. *Conochiloides dossuarius* (Hudson) (M-8*b*) Japan, Manchuria, Sumatra, Bali.
2. *Conochilus hippocrepis* (Schrank) (N-1*a*, 1*b*, 2*b*; M-4) Japan, China, Manchuria.
3. *Conochilus unicornis* Rousselet (M-7*a*, 7*b* [Hada, 1936]) Japan, China, Manchuria.

Order PLOIMA
Family NOTOMMATIDAE

4. *Monommata grandis* Tessin (N-1*b*) Japan, Manchuria, Sumatra.
5. **Notommata* sp. (N-1*b*).
6. *Scaridium eudactylotum* Gosse (E-15*b*) Japan, China, Manchuria.
7. *Diaschizza gibba* (Ehrenberg) (N-1*b*) Japan, China, Sumatra, Java.

Family SYNCHAETIDAE

8. *Synchaeta longipes* Gosse (M-7*b*).
9. *Synchaeta oblonga* Ehrenberg (N-2*a*; M-7*b*; E-9*a*, 9*b*, 9*c*, 15*a*) Japan.
10. *Synchaeta tremula* (O. F. Müller) (N-7*b*; E-9*c*) Japan, China, Java.

**Synchaeta* spp. (N-2*c*; E-12, 14).

11.**Ploesoma hudsoni* Imhof (M- [Hada, 1936]) Japan.
12. *Poesomla triacanthum* Bergendal (N-1*b*) Japan.
13. *Ploesoma truncatum* (Levander) (N-2*a*, 2*c*; M-7*b*, 8*b*) Japan, Manchuria.
14. *Polyarthra euryptera* (Wierzejski) (M-7*a*, 7*b*, 8*a*, 8*b*; W-16) Japan, China, Manchuria.
15. *Polyarthra trigla* (Ehrenberg) (N-1*a*, 1*b*, 2*a*, 2*c*; M-3, 5, 7*a*, 7*b* [Hada, 1936], 8*a*; E-9*a*, 9*b*, 9*c*, 10, 11, 12, 14, 15) Japan, China, Manchuria, Java.
16. *Polyarthra trigla* var. *major* Burckhardt (M-7*a*, 7*b*) China.
17. *Polyarthra trigla* var. *remata* Skorikov (M-7*a*, 7*b*) China.

Family TRICHOCERCIDAE

18. *Trichocerca capucina* Wierzejski et Zacharias (M-5, 7*a*, 7*b* [Hada, 1936]) Japan, China, Manchuria.
19. *Trichocerca cristata* Harring (E-9*c*) Japan, China, Manchuria.
20. *Trichocerca cylindrica* (Imhof) (M-7*a*, 7*b*; E-9*c*) Japan, Manchuria.
21.**Trichocerca elongata* (Gosse) (M-[Hada, 1936; Kawamura, 1916]) Japan, China, Manchuria.
22. *Trichocerca longiseta* (Schrank) (N-1*a*; M-8*a*, 8*b*; E-12, 14) Japan, China, Manchuria.
23. *Trichocerca pusilla* Jennings (M-7*b* [Hada, 1936]) Japan, China, Manchuria.
24. *Trichocerca stylata* (Gosse) (M-7*b*) Japan, Manchuria.
25. *Diurella brachyura* (Gosse) (E-15*b*) Japan, China, Manchuria, Sumatra, Java.
26. *Diurella porcellus* (Gosse) (E-15*b*) Japan, China, Manchuria.
27. *Diurella stylata* Eyferth (M-5, 7*b*; E-14) Japan, China, Manchuria, Sumatra, Java.
28. *Diurella tigris* (O. F. Müller) (N-1*b*; M-[Hada, 1936]; E-15*a*, 16*b*) Japan, Manchuria.
29. *Diurella weberi* Jennings (E-15*a*) Sumatra, Java.

Family ASPLANCHNIDAE

30. *Asplanchna priodonta* Gosse (N-2*a*, 2*b*, 2*c*; M-3, 5 [Sato, 1941], 7*a*, 7*b* [Hada, 1936], 8*a*, 8*b*; E- [Sato, 1941], 10, 13, 15*a*) Japan, China, Manchuria. Java.

Family BRACHIONIDAE

31.**Brachionus angularis* Gosse (E- [Sato, 1941]) Japan, China, Manchuria, Java.
32. *Brachionus angularis* var. *bidens* (Plate) (M-3, 8*a*, 8*b*) Japan.
33. *Brachionus budapestinensis* Daday (M-3) Japan, China, Manchuria, Formosa.
34. *Brachionus calyciflorus* Pallas (M-8*a*; E-14) Japan, China, Manchuria, Java.
35. *Brachionus calyciflorus* f. *amphiceros* Ehrenberg (M-3, 8*a*) Japan, China, Manchuria.
36. *Brachionus calyciflorus* f. *anuraeiformis* Brehm (M-3, 8*a*) Japan, China, Manchuria.
37. *Brachionus calyciflorus* var. *dorcas* Gosse (M-3, 8*a*) Japan, China, Manchuria.
38. *Brachionus calyciflorus* var. *dorcas* f. *spinosus* Wierzejski (M-3, 8*a*) Japan, China, Manchuria.
39. *Brachionus forficula* Wierzejski (M-5) Japan, China, Manchuria.
40. *Brachionus quadridentatus* Hermann (M-3; E- [Sato, 1941]) Japan, China, Manchuria, Java.
41. *Brachionus quadridentatus* var. *brevispinus* (Ehrenberg) (E-9*c*) Japan, China, Manchuria.
42. *Brachionus urceolaris* O. F. Müller (E-[Sato, 1941], 14) Japan, China, Manchuria.
43.**Platyias patulus* (O. F. Müller) (M-[Hada, 1936]) Japan, China, Manchuria, Java, Bali.
44. *Keratella cochlearis* (Gosse) (N-2*a*, 2*b*; M-3, 5, 6, 7*a*, 7*b* [Hada, 1936], 8*a*, 8*b*; E-10, 13, 14, 15*a*, 15*b*) Japan, China, Manchuria, Java.
45. *Keratella cochlearis* var. *macracantha* (Lauterborn) (N-1*a*, 1*b*) Japan.
46. *Keratella cochlearis* var. *tecta* (Gosse) (N-2*a*;

M-5, 7*a*, 7*b* [Hada, 1936], 8*a*, 8*b*; E-9*b*, 12, 14) Japan, China, Manchuria.

47. *Keratella cochlearis* var. *tecta* f. *micracantha* (M-5, 7*a*, 7*b*).
48. *Keratella cruciformis* (Thompson) var. *eichwaldi* (Levander) (E-9*a*, 9*b*, 9*c*) Japan.
49. *Keratella quadrata* (O. F. Müller) (N-1*b*, 2*a*, 2*c*; W-16) Japan, China, Manchuria.
50. *Keratella serrulata* (Ehrenberg) (N-1*b*) Japan.
51. *Keratella valga* (Ehrenberg) f. *asymmetrica* Barrois et Daday (M-3, 8*b*; E- [Sato, 1941]) Japan, China, Manchuria.
52. *Keratella valga* (Ehrenberg) f. *monstrosa* Barrois et Daday (M-3, 5) Japan, China, Manchuria.
53. *Keratella valga* (Ehrenberg) f. *tropica* Apstein (E-9*a*, 9*b*, 9*c*, 12) Japan, China, Manchuria.
54. *Notholca acuminata* Ehrenberg (E-9*a*, 9*c*, 12) Japan, Manchuria.
55. *Notholca labis* Gosse (E-9*b*, 12) Japan.
56. **Anuraeopsis* sp. (M- [Hada, 1936]).

Family EUCHLANIDAE

57. *Euchlanis alata* Voronkov (N-1*b*) Japan.
58. *Euchlanis dilatata* Ehrenberg (E-9*a*, 9*b*, 9*c*, 12, 14; W-16) Japan, China, Manchuria, Sumatra.
59. *Euchlanis triquetra* Ehrenberg (N-1*b*) Japan.
60. *Lecane brachydactyla* (Stenroos) (N-1*b*, 1*c*) Japan.
61. *Lecane ludwigii* (Eckstein) (E-15*b*) Japan, China, Manchuria, Sumatra, Java.
62. *Lecane luna* (O. F. Müller) (M- [Hada, 1936; Kawamura, 1917]; E-9*b*) Japan, China, Manchuria, Sumatra, Java.
63. *Monostyla arcuata* Bryce (M-8*a*) Japan, China, Manchuria, Sumatra.
64. *Monostyla crenata* Harring (N-1*b*) Japan, China, Manchuria, Java.
65. *Monostyla hamata* Stokes (N-1*c*) Japan, China, Manchuria, Sumatra, Java, Bali.
66. *Monostyla lunaris* (Ehrenberg) (N-1*a*, 1*b*; M- [Hada, 1936]; W-16) Japan, China, Manchuria, Sumatra, Java.
67. *Monostyla pyriformis* Daday (E-11) Japan, Sumatra, Java.
68. *Lepadella acuminata* (Ehrenberg) (E-15*b*) Japan, Sumatra.
69. **Lepadella borealis* Harring (M- [Hada, 1936]).
70. *Lepadella ovalis* (O. F. Müller) (N-1*b*; E-12) Japan, China, Manchuria, Sumatra.
71. *Colurella adriatica* (Ehrenberg) (M-8*b*; E-9*a*) Japan, China.
72. *Colurella lepta* (Gosse) (E-9*b*, 9*c*) Japan, China.
73. *Colurella obtusa* (Gosse) (E-9*a*, 9*b*, 9*c*) Japan, China, Sumatra.
74. *Mytilina trigona* (Gosse) (N-1*b*) Japan.
75. *Mytilina ventralis* (Ehrenberg) (N-1*b*) Japan, China, Manchuria.
76. **Mytilina ventralis brevispina* (Ehrenberg) (M- [Hada, 1936]) Japan, China, Manchuria, Java.
77. *Trichotria tetractis* (Ehrenberg) (N-1*b*) Japan, China, Manchuria, Sumatra, Java.
78. *Trichotria truncata* (Whitelegge) (M- [Hada, 1936], 8*a*; E-14, 15*b*) Japan, Manchuria.

Family FILINIIDAE

79. *Filinia longiseta* (Ehrenberg) (N-2*a*, 2*b*; M-3, 5, 8*a*, 8*b*; E-9*c*, 15*a*) Japan, China, Manchuria, Sumatra, Java.
80. **Pedalia mira* (Hudson) (E- [Sato, 1941]) Japan, China, Manchuria, Sumatra.

Family TESTUDINELLIDAE

81. *Testudinella bidentata* (Ternitz) (N-1*a*) Japan.
82. *Testudinella patina* (Hermann) (E-9*a*, 9*b*, 9*c*, 15*b*) Japan, China, Manchuria, Sumatra, Java.

Order BDELLOIDA

Family PHILODINIDAE

83. **Rotaria* sp. (N-1*c*; E-9*b*, 10, 15*b*).

NOTEWORTHY SPECIES

Brief descriptions of some unusual species which have been observed are given here.

Euchlanis alata Voronkov, 1912
Pl. 2, Figs. 26, 26*a*, 26*b*, 27

1912 *Euchlanis alata* Voronkov, Mus. Zool. [St. Petersburg], Ann. 16: 210.

Dorsal plate: length, 335 μ; width, 315 μ; frontal width, 160 μ (winged form). Foot, 110 μ; toe, 18 μ.

The body consists of two plates, dorsal and ventral, the dorsal one being much the larger, about twice as wide as the ventral. No keel is present on the back. In the winged form, both sides of the dorsal plate are expanded to at least two thirds the length. The posterior tip of the wing is pointed, turned slightly upward, making the greatest width. The central posterior part gradually becomes low and has no notch. At the anterior extremity a large V-shaped notch is present. The wingless form is elliptical.

The ventral plate is slightly convex, elongate elliptical, its posterior border parallel to that of the dorsal plate.

The foot is large, two-jointed, with one pair of toes.

A large central, anterior eye-spot is present.

Both the winged and the wingless forms were collected from the littoral region of Tai-taik (1*b*). They are 20 per cent larger than the form recorded by Myers (1930). According to his note, various stages of "wing" development were found in this species in the acid waters of Mt. Desert Island, Maine, but the forms from Atlantic County, New Jersey, had no lateral wing-like processes. At that time, this species had been found in only four places in the world, i.e., near Moscow, Russia, Arc-en Barrois (Haute-Marne), France, and the two localities mentioned above. The present finding is probably the first record in the Far East.

Euchlanis triquetra Ehrenberg, 1838
Pl. 2, Figs. 28, 28*a*

1838 *Euchlanis triquetra* Ehrenberg, Infusionsthierchen, p. 461.

Length, 220 μ; width, 240 μ.

The dorsal plate is larger than the ventral plate, is triradiate in cross section, and has a median keel. The sides are roundly expanded; in lateral view the highest portion is at the center, gradually decreasing in height anteriorly and decreasing suddenly near the posterior end. The ventral plate is slightly concave, about two thirds as wide as the dorsal plate. This species was found in the littoral region of Tai-taik (1*b*).

Testudinella bidentata (Ternitz, 1892)
Pl. 3, Figs. 34, 34*a*

1892 *Pterodina bidentata* Ternitz, Rotatorien der Umgebung Basels, p. 20.

This species is nearly circular in shape. The dorsal plate has a convex frontal edge with a small central notch. On each side of the hind portion a small triangular projection is present, the tips of which are 100 micra apart. In the ventral plate the frontal edge is concave, but it swells out slightly centrally. A polygonal foot-opening is situated at the posterior extremity. In cross section (Fig. 34*a*), the ventral side is flat, but the dorsal side forms a low arc. This species was found in the region off the shore of Tai-taik (1*b*). In Japan there is only a single record from the Koishikawa Botanic Garden of Tokyo (T. Kawamura).

Ploesoma triacanthum (Bergendal, 1892)
Pl. 3, Fig. 36

1892 *Gastroschiza triacanthum* Bergendal, Univ. Lundensis, Acta 28: 1.

The anterior end of the head is separated into three triangular processes of which the central one is the longest. In general, this portion bends downward as a shield-like head. This species was found only in the littoral region of Tai-taik (1*b*).

Keratella cruciformis (Thompson, 1892) var. **eichwaldi** Levander, 1894
Pl. 1, Fig. 14, 15

1892 *Anuraea cruciformis* Thompson, Liverpool Biol. Soc., Proc. 6: 77.

1894 *Anuraea eichwaldi* Levander, Soc. Fauna Flora Fennica, Acta 12: 62.

Total length, 120 μ.

This brackish-water species was found in every part of Lake Kandong-po (9*a*, *b*, *c*). The hind process is absent. Both the punctate and reticular sculptures are remarkable. In the dorsal lorica, the frontal plate is very short (*c.* 10 μ), but the first carinal plate is remarkably long (*c.* 75 μ).

Keratella serrulata (Ehrenberg, 1838)
Pl. 2, Fig. 20

1838 *Anuraea serrulata* Ehrenberg, Infusionsthierchen, p. 508.

Total length: 195 μ (from the frontal notch to the posterior end, 130 μ, length of the ventral plate, 120 μ). Width: frontal end 98 μ, greatest, 112 μ, hind end, 54 μ; frontal processes: central, 65 μ, sublateral, 22 μ, lateral, 25 μ.

Both the punctate and reticular sculptures are remarkable in the dorsal plate. The last central plate is hexagonal, and from its posterior corner a central line runs posteriorly. Both posterior corners project slightly. The central pair of the frontal processes are long and stout, bending downward remarkably near the tip. This is a characteristic species of dystrophic water. Skadowski (1923) has found this species in moorland waters, in which the *p*H values ranged from 3.2 to 4.5. The *p*H value of the present locality (1*b*) measured as high as 6.3.

DISTRIBUTIONAL RELATIONSHIPS

As already noted, in the western region only a collection of potamoplankton was made, on the river Taidong-gang (16), where only five rotatorian species were found. This number is not small for a collection from a river, but there are very few individuals of the species, four of which were found in three other regions. Therefore, the fauna of the western region should not be considered here.

The species common to the three other regions number eight, or less than 10 per cent. In general, these species are well known to be widely distributed animals. They are all pelagic except *Diurella tigris*. The frequencies of occurrence are as follows:

Polyarthra trigla	12 stations
Keratella cochlearis	10 stations
Keratella cochlearis var. *tecta*	7 stations
Asplanchna priodonta	9 stations
Filinia longiseta	6 stations
Synchaeta oblonga	4 stations
Trichocerca longiseta	4 stations
Diurella tigris	3 stations

The number of species peculiar to any one region of northern, middle, or eastern Korea are 17, 25, and 19, respectively. The total peculiar to one region, 61, is three fourths of the total number. Of the 13 species remaining, 8 are found both in the middle and eastern regions, 3 others are found both in the northern and middle regions. One species (*Lepadella ovalis*) is found in both the northern and the eastern regions.

The collections in northern Korea were made chiefly in summer. Seventeen species obtained from this region are, without exception, found only from Tai-taik. Only one from Tai-taik, *Keratella quadrata*, is also found in the collection from Puchon-ho, and in the Taidong-gang of the western region. This suggests that the conditions of Tai-taik differ greatly from those of any other waters visited. The occurrence of *Keratella cochlearis* var. *macracantha* is worthy of note as this collection was made in midsummer and this has been considered heretofore to be a winter form.

In Tai-taik 23 species of Rotatoria were found, i.e., 8 from the pelagic, 18 from the littoral, and 3 among the mosses of the marginal region.

In a work on the plankton of Lake Puchonho, the present author (1941) has noted that at the early stage of the development of the reservoir many heleoplankters such as *Conochilus hippocrepis* were found, but after several years the condition of the water so changed that *Synchaeta* spp. and *Keratella quadrata* ap-

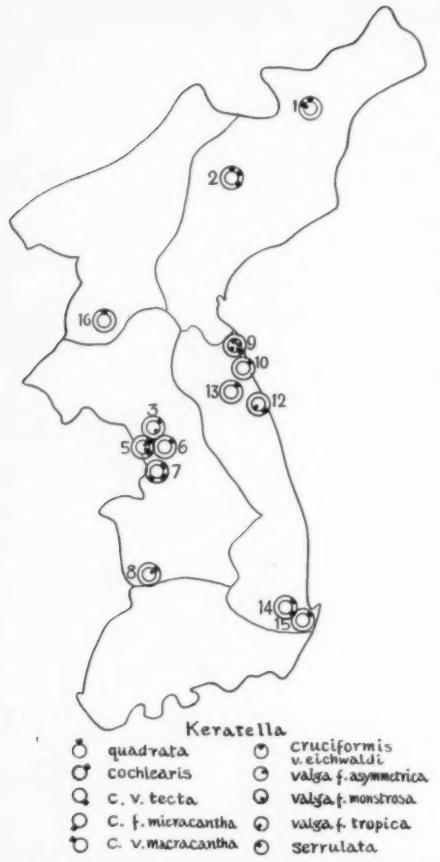

Fig. 2. Occurrences of the genus *Keratella* in Korea.

peared. In July, 1941, *Asplanchna priodonta* was the predominant species, being especially abundant in the epilimnion. The nine species reported from this reservoir, excepting *Keratella quadrata*, are common to the middle and eastern regions.

In the middle region, three of the samplings were made by Sato from localities in and around Seoul. Among them, one from a pool at Shindo-cho (4) contained only a single species, *Conochilus hippocrepis*. The collections from a pool at Shochudan (3) and from Eitoho (5) contained 11 species each. A remarkable condition common to these two localities is the richness of species belonging to the family Brachionidae, i.e., eight from the former and six from the latter. It is particularly noteworthy that species of a warm-water type are found here, e.g., *Brachionus forficula* in the latter and *Keratella valga* in both localities.

As potamoplankton of the Hang-gang (6), only a single species (*Keratella cochlearis*) was found, but Sato (1939) has reported two species, *Asplanchna priodonta* and *Testudinella patina*, from the same river in winter.

Besides our collection from Seiko (7), those taken by Kawamura on June 2, 1936 (7*a*), were examined. Notwithstanding the fact that the season of collection was quite different, 11 species found in early summer were all included among the 18 species collected in

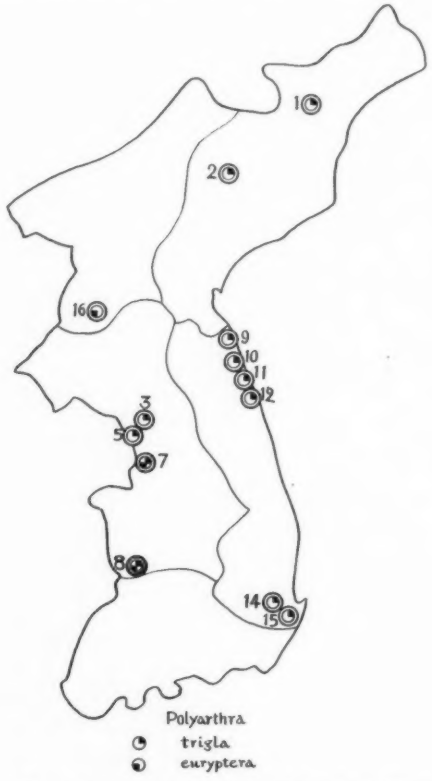

Fig. 3. Occurrences of the genus *Polyarthra* in Korea.

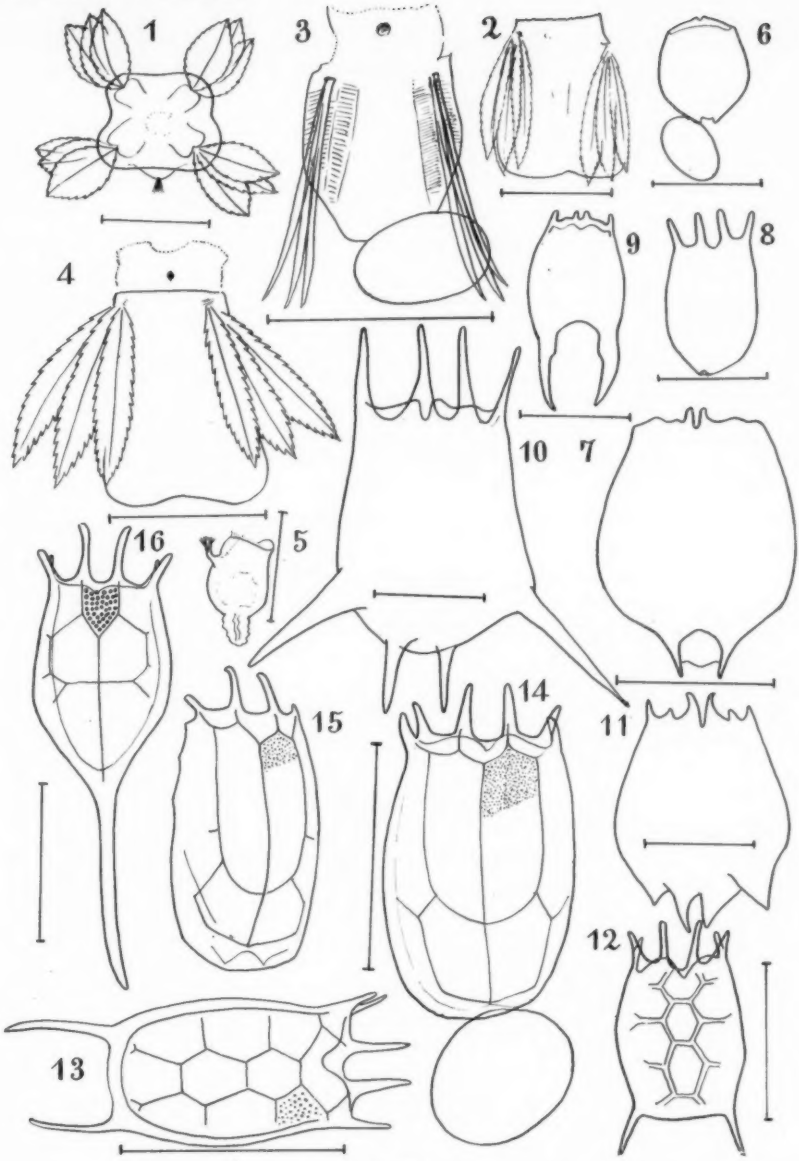

PLATE I

(Line scales represent 100 micra except those marked otherwise)

FIG. 1. *Polyarthra euryptera*
FIG. 2. *Polyarthra trigla*
FIG. 3. *Polyarthra trigla* var. *remata*
FIG. 4. *Polyarthra trigla* var. *major*
FIG. 5. *Conochiloides dossuarius*
FIG. 6. *Brachionus angularis*
FIG. 7. *Brachionus angularis* (type)
FIG. 8. *Brachionus budapestinensis*
FIG. 9. *Brachionus forficula*
FIG. 10. *Brachionus calyciflorus*
FIG. 11. *Brachionus quadridentatus*
FIG. 12. *Keratella quadrata*
FIG. 13. *Keratella valga* f. *tropica*
FIG. 14. *Keratella cruciformis* var. *eichwaldi*
FIG. 15. *K. cruciformis* var. *eichwaldi* (from Sakhalin, after Yamaguchi)
FIG. 16. *Keratella cochlearis* var. *macracantha*

late autumn. In both cases *Asplanchna priodonta* and *Keratella cochlearis* were found abundantly. The length of the posterior process of the latter species varies greatly, showing stages almost continuous from *tecta*-type to *typica*-type (Fig. 2). *Polyarthra trigla* shows a very wide distribution (Fig. 3). In the specimens from Seiko, two varieties were included (var. *major* and var. *remata*).

Of 17 species reported by Hada (1936) from this lake, 7 were also obtained in the present survey. They belong chiefly to the pelagic species, while the remainder are those of the creeping type. The occurrence of such bottom-inhabiting forms may be attributed to vertical hauls. The total number of species recorded from this lake is 28. This is the greatest number of species found in any single locality in Korea.

Seventeen species were found in two collections from Kanggyong. One collection from a small pond (8*a*) contained 13 species. Of these, *Brachionus calyciflorus* shows great variability, many types such as *typica*, *amphiceros*, *anuraeiformis*, *dorcas*, and *spinosus* being identified. Another collection from a pond (8*b*) contained 10 species, of which 7 are also found in pond 8*a*. No remarkable morphological characteristics can be found.

In the eastern region, the greatest number of species was found from Kangdong-po (9*a*, *b*, *c*). The total here is 23, if Sato's (1941) record is added. The present collections were made from a small boat at three stations on the lake. *Notholca* occur in all three stations, *Notholca acuminata* in the first and third stations, and *Notholca labis* in the second. These species have been known as brackish-water forms and were also found in Lake Kam-ho (12).

Of eight species found in Kam-ho, six are also found in Kangdong-po.

The remaining two localities are located in the far southern region of eastern Korea, near the coast of the Japan Sea. An unnamed pond is situated to the west of the Bukkokuji railway station (14). Its area is considerable and it receives several brooks from the rice fields around it. Eight species were found both in the collections from the surface and in those from the bottom, the total being 14. There are two common species in these two places, one pelagic and the other a creeping species —*Keratella cochlearis* and *Diurella tigris*.

Throughout all the regions surveyed, the species belonging to the genus *Keratella* occur most frequently. The features of its distribution seem to be characteristic. *Keratella cochlearis* in both forma *typica* and var. *tecta* is distributed in the northern, middle, and eastern regions, whereas the remaining forms seem to be limited to a single region. *K. quadrata*, *K. serrulata*, and *K. cochlearis* var. *macracantha* are distributed chiefly in the northern region, *K. cochlearis* f. *micracantha*, *K. valga* f. *asymmetrica*, and f. *monstrosa* in the middle, and *K. cruciformis* var. *eichwaldi* and *K. valga* f. *tropica* in the eastern region. *K. quadrata* was, however, found also in the western region, and its forma *asymmetrica* has been recorded by Sato (1941) as a summer plankton animal of Kangdong-po.

It is remarkable that the distribution of species of southern origin, such as *K. valga* f. *tropica*, have shown a late autumn occurrence in the district of the Japan Sea coast. This suggests that the influence of the northward-flowing warm current along the coast of North Korea upon the climate of this district may be one of the factors acting in the distribution of this species. It is also interesting that, in spite of the collections having been made in the northern region in summer and in the southern region in late autumn, *K. quadrata* appears to be distributed strictly in the northern part and *K. valga* only from the southern region (Fig. 2).

Species belonging to the genus *Brachionus* occurred in comparatively few places. Two of these localities were the stations in and about the city of Seoul where the collections were made by Sato. In the present survey, *Brachionus* species were found in only three localities, i.e., Kanggyong, the Kangdong-po, and

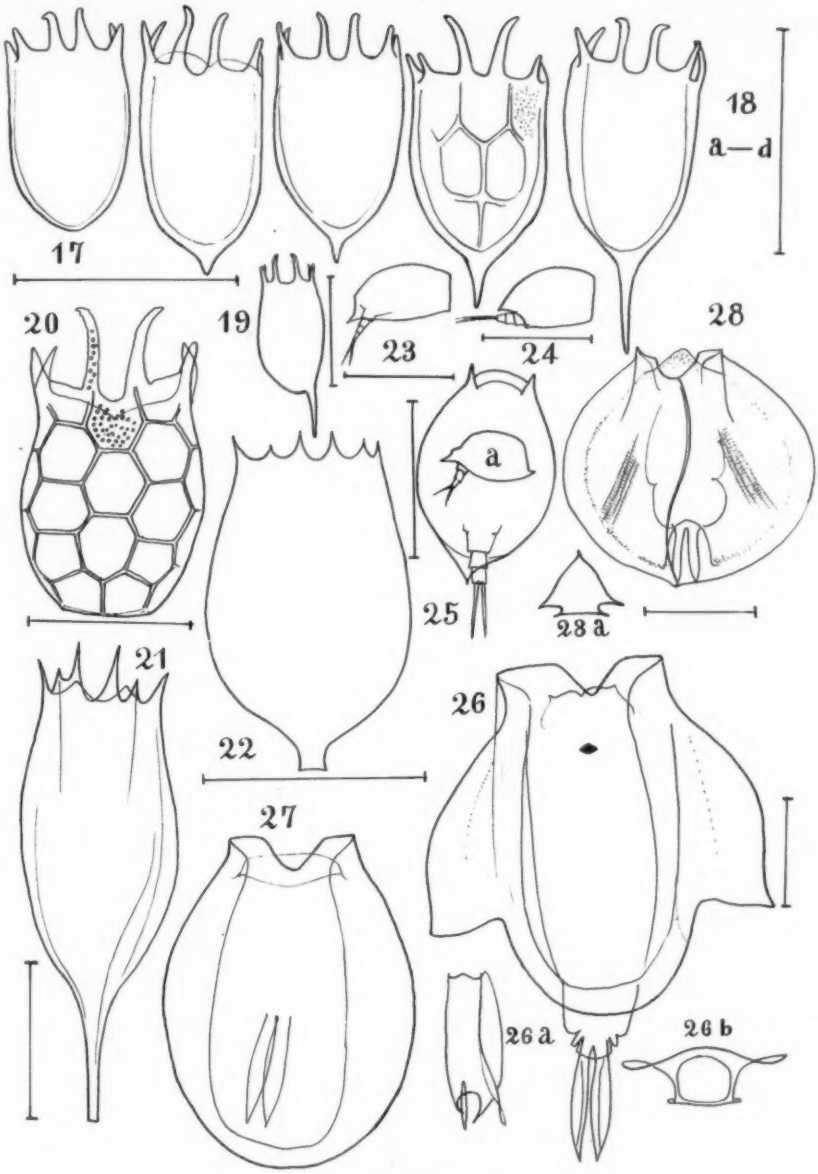

PLATE II

(Line scales represent 100 micra except those marked otherwise)

FIG. 17. *Keratella cochlearis* var. tecta
FIG. 18*a–c*. *Keratella cochlearis* f. *micracantha*
FIG. 18*d*. *Keratella cochlearis* s. str.
FIG. 19. *Keratella valga* f. *monstrosa*
FIG. 20. *Keratella serrulata*
FIG. 21. *Notholca acuminata*
FIG. 22. *Notholca labis*
FIG. 23. *Colurella lepta*
FIG. 24. *Colurella obtusa*
FIG. 25. *Lepadella acuminata* (*a:* side view)
FIG. 26. *Euchlanis alata* (*a:* side view; *b:* frontal view)
FIG. 27. *Euchlanis alata* (wingless form)
FIG. 28. *Euchlanis triquetra* (*a:* cross section)

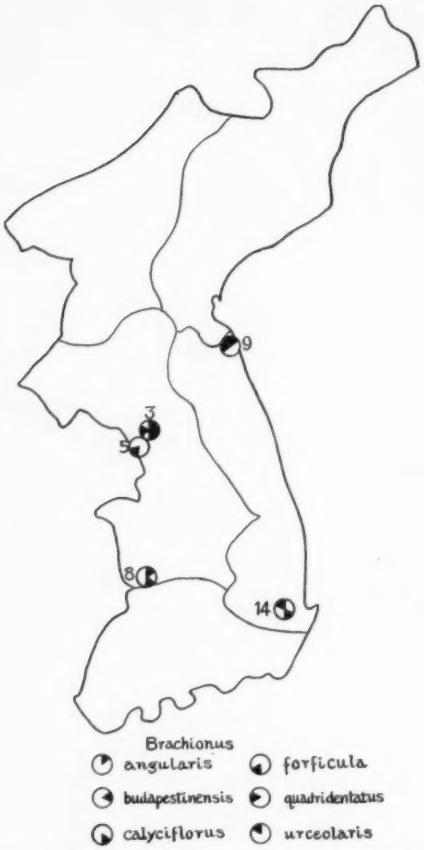

Fig. 4. Occurrences of the genus *Brachionus* in Korea.

the Gan-o-chi. In Gan-o-chi, two species of *Brachionus* (*B. urceolaris* and *calyciflorus*) occurred, whereas in Kangdong-po only a single species (*B. quadridentatus* var. *brevispinus*) was found. At Kanggyong two species (*B. angularis* var. *bidens* and *B. calyciflorus*) occurred; five forms of *B. calyciflorus* were observed in the pond along the railroad (8*a*) as previously mentioned.

The values of the hydrogen ion concentration of water in these places indicate that, although the range tolerated by this genus would be rather wide, the organisms prefer alkaline waters. This seems also to correspond to conditions in Korean waters, though the occurrences of this genus are limited to fewer localities. As is mentioned above, none of them was found in the northern region. As far as our collections are concerned, one species was found from the middle and two from the eastern region, a fourth was common to both. Besides these, two (*budapestinensis* and *forficula*) were found in the collections made by Sato. They are warm-water forms. Thus, a total of six species of *Brachionus* is known from the middle and eastern regions (Fig. 4).

SUMMARY

1. Plankton collections were made in Korea at 16 places, which may be classified roughly into four regions—the northern, western, middle, and eastern.

2. Fifty-eight species of Rotatoria were identified in these collections. In addition, seven species can be added from previous records. With the addition of eight varieties and seven forms, plus three undeterminable species, the total number becomes 83.

3. The species of wide distribution are *Keratella cochlearis* and *Polyarthra trigla*, both including several varieties or forms.

4. Species of *Brachionus* were found only in a few stations.

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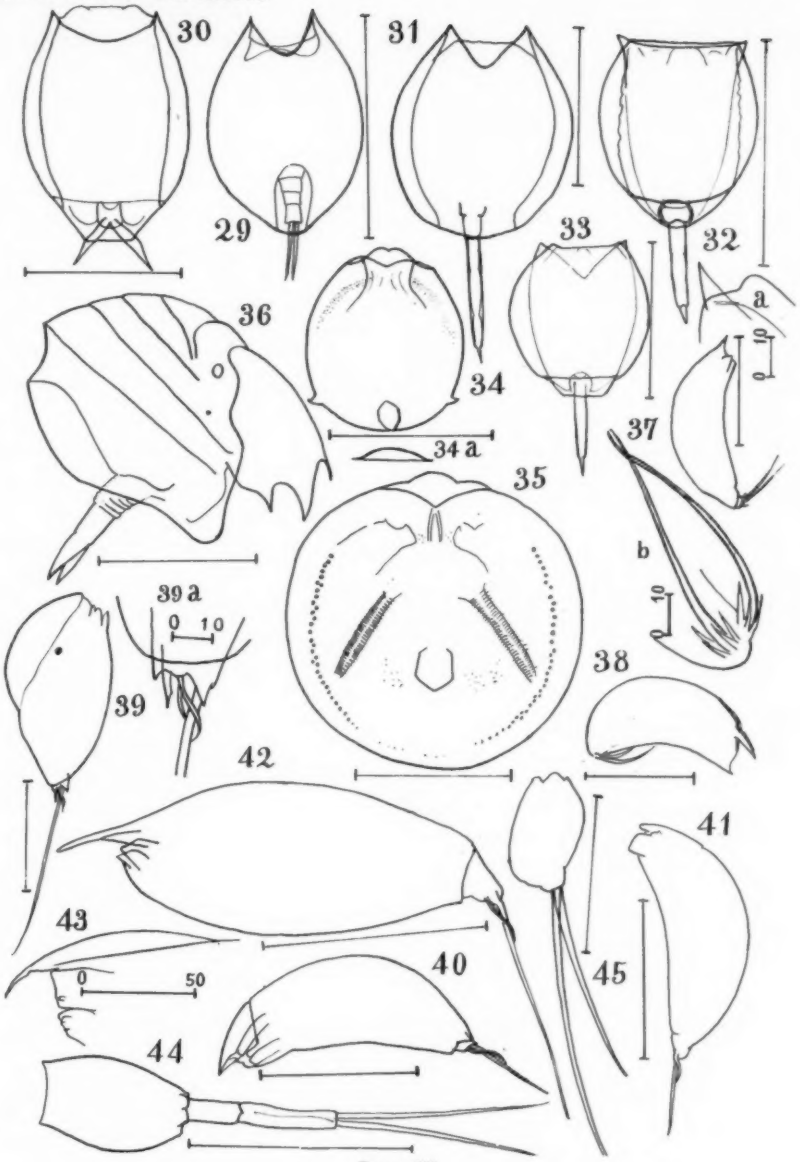

PLATE III

(Line scales represent 100 micra except those marked otherwise)

FIG. 29. *Lepadella ovalis*
FIG. 30. *Lecane brachydactyla*
FIG. 31. *Monostyla lunaris*
FIG. 32. *Monostyla furcata*
FIG. 33. *Monostyla crenata*
FIG. 34. *Testudinella bidentata* (*a:* cross section)
FIG. 35. *Testudinella patina*
FIG. 36. *Ploesoma triacanthum*
FIG. 37. *Diurella tigris* (*a:* head; *b:* toes)
FIG. 38. *Diurella porcellus*
FIG. 39. *Trichocerca cristata*
FIG. 40. *Trichocerca capucina*
FIG. 41. *Trichocerca pusilla*
FIG. 42. *Trichocerca longiseta*
FIG. 43. *Trichocerca cylindrica* (head)
FIG. 44. *Scaridium eudactylotum*
FIG. 45. *Monommata grandis*

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Vernacular Names of the Plants of Bikini, Marshall Islands
Pacific Plant Studies 12[1]

HAROLD ST. JOHN AND LEONARD E. MASON[2]

IN 1946, in connection with the atomic bombing at Bikini, "Operation Crossroads," general scientific studies were made upon this coral atoll in the northern Marshall Islands, in the central Pacific Ocean. In the plant kingdom general collections were made, even of the bacteria and the phytoplankton. The remaining plant groups were collected in 1946 by Dr. W. R. Taylor, a specialist on marine algae, and he studied and reported on most of them. His general account of the flora has now appeared in book form (Taylor, 1950). In this book he includes 41 species of angiosperms as composing the terrestrial flora of Bikini. Taylor did not obtain a record of the native names of the plants in use by the people of Bikini, who had already been removed to Rongerik atoll, since their home island was to become dangerously radioactive. They went first to Rongerik which, after 2 years of residence, proved inadequate, then temporarily to Kwajalein until a final relocation was made in November, 1948, at Kili Island in the southern Marshalls.

Appreciating the value of the Marshallese ethnobotany, St. John urged Mason, who was about to visit Kili and the Bikini people on an inspection trip, to attempt to compile it from native informants. On August 14, 1949, Mason spent 2 hours collecting plants, beginning at the village on the north shore, following the beach westward to the end of the island, and then cutting back to the village through the interior of the island. The plants collected and here listed are those recognized as characteristic Bikini plants by Jibaj, Ejkel, and Joaj, male adults and former residents of Bikini, who were selected because of their knowledge of Bikini's plant life. Seventeen plants common to Kili and Bikini were collected, and they have been identified by St. John and deposited in the Bishop Museum. The informants were in unanimous agreement about the naming of 16 of them, but one man disagreed on the spelling of a single vernacular name, that for *Eleusine indica*, although the difference in their spelling and pronunciation was slight and was due to the inadequacies of the orthography used by the Marshallese in spelling their language.

The orthography here used is that established by the Protestant Mission and published in their Bible in Marshallese, printed in 1885. Vowel pronunciation is as follows: a, e, o, and u are like those in Spanish; ā, as in English *hat;* i, as in *bit;* ō is a central vowel somewhat like the u in English *cut* but higher in the mouth. Frequently certain vowels are preceded by a definite w sound. The consonants t and d are spelled as t, but when placed medially in a word are pronounced more like d; the same applies to the pair k and g, k

[1] This is the twelfth in a series of papers designed to present descriptions, revisions, and records of Pacific island plants. The preceding papers were published as: *Bernice P. Bishop Mus., Occas. Papers* 17 (7), 1942; 17 (13), 1943; 18 (5), 1945; *Amer. Fern Jour.* 35: 87–89, 1945; *Torrey Bot. Club, Bul.* 73: 588, 1946; *Pacific Sci.* 1(2): 116, 1947; 2(2): 96–113, 1948; 2(4): 272–273, 1948; 5(3): 279–286, 1951; 6(2): 145–150, 1952; *Webbia* 8: 225–228, 1951.

[2] Chairman, Department of Botany and Chairman, Department of Anthropology and Sociology, University of Hawaii, respectively. Manuscript received May 10, 1951.

being written to stand for both, though pronounced more like g when placed medially. The letter g is used only with the sound *ng* which the Marshallese spell as n̄.

VERNACULAR NAMES USED BY NATIVES OF BIKINI

Pandanus sp. "Bōb anbwiri"; a second variety "bōb erwan." (Because the specimens of the fruits were lost in transit, specific identification could not be made.)

Eleusine indica (L.) Gaertn. "Ujuj" (or "ujoj"). Although this plant was not collected by Taylor on Bikini, it is common on many of the Marshall Islands, and this report for Bikini is trustworthy. "Ujuj" is a general name for a number of weeds, mostly grasses. This one may be good in treatment of diarrhea.

Cocos nucifera L. "Ni." Very generally useful to the Marshallese.

Tacca Leontopetaloides (L.) Ktze. "Mōkmōk." It is good in the treatment of diarrhea when eaten by itself, or as food when mixed with coconut cream, *Pandanus* fruit pulp, sugar, or toddy. The seed (fruit) is wrapped in a piece of coconut cloth, "inubil," and used as a scent-stimulant by pregnant women experiencing morning-sickness.

Fleurya ruderalis (Forst. f.) Gaud. "Nen kōt-kōt." It is used only for medicine. The leaves, root, and stem are crushed, the juice thus obtained being mixed with water and coconut milk. The potion is given to a person who is distressed and yelling or crying, in order to make the evil spirit go away. This is a new record for Bikini, as Taylor did not find it there. However, it is not unexpected as it is known on Eniwetok and is widespread in the Marshalls.

Pisonia grandis R. Br. "Kangōl." A tree useful for house timbers, especially posts, because the wood lasts a long time.

Triumfetta procumbens Forst f. "Atat." A ground creeper, said to be the most valuable vine in Bikini. The bark is stripped off, then, by fretting in the hands, the easily broken outer bark is removed. The smooth, fibrous band of inner bark is dried in the sun to an orange-brown color of varying shades and used as a fiber to provide ornamentation in finely woven *Pandanus* matting. The leaves are crushed and placed as medicine on open wounds. Sometimes the leaves, yellow and brown, and the woody part of the stem are mashed, giving a liquid used as a potion for treatment of gonorrhea.

Hibiscus tiliaceus L. "Lwo" (pronounced like the English "law"). A tree, the wood of which is light, for which reason it is used for masts and booms of sailing craft and for pieces of the outrigger frame of canoes. The inner bark is used for handicraft fiber, for cord, or for string.

Pemphis acidula Forst. "Konge." A tree, the hard wood of which is used for the canoe keel, for the apex of the canoe mast, and for the pieces fitted into the canoe bow and stern where the sail booms are lashed. It is also used for the husking stake ("rōn"), for the digging stick to uproot *Tacca*, and for a beater for pounding soaked coconut husks when making sennit ("eokwal").

Terminalia litoralis Seem. "Ekōng." A large tree, the wood of which is used for making the elongate bowls in which the "beru" (fruits of *Pandanus* and tubers of *Tacca*) and the "bwiru" (preserved *Artocarpus* fruits) are mixed. The leaves and root are used for medicine.

Ipomoea tuba (Schlecht.) Don. "Mar bōle." A vine which is regarded as harmful, since it kills any tree on which it grows. It has small roots (tubers as small as marbles) which long ago were used for food. After being cooked overnight in the "umum" (underground oven), they were eaten like a potato. Previous records from the Marshalls have been called *I. grandiflora* or *I. alba*, but these were misdeterminations.

Cordia subcordata Lam. "Kōno." A tree with red flowers that are used in making leis. The wood is used for many purposes in Bikini where the tree occurs in great abun-

dance, more so than elsewhere in the Marshalls. The wood is used for making the block on which *Pandanus* or *Cocos* fiber hats are plaited, for the hull, bow and stern pieces, and interior hull braces of a canoe, and for paddles. Recently it has been used for many tourist souvenirs, such as outrigger canoe models, bowls, cups, and clogs.

Messerschmidia argentea (L. f.) I. M. Johnston. "Kiren." A tree which, if large, is used for canoe hulls, if small, for the curving booms of the outrigger. The bark is useful. First the dry outer bark is scraped off and removed, then the inner bark is scraped, making wet shavings that are good for placing on a cut. The young leaves are pounded to obtain a juice which is good to drink for a stomach-ache or for any general ache in the body. The seeds are pounded to obtain a juice which is applied to gum boils or canker sores in children's mouths; it is also good for treatment of diarrhea.

Guettarda speciosa L. "Wut." A tree, the wood of which is useful for house frames, house posts, outrigger booms, and the diagonal braces between the outrigger and the canoe hull. When large, it is also used for canoe hulls. The leaves are medicinal.

Morinda citrifolia L. "Nen." A tree, the wood of which is used for the framework of a house. The leaf, root, and fruit are strongly medicinal. The seeds are pulverized and the pulp applied to any tooth which is causing pain. The root is scraped, then the scrapings, together with young coconut husk, are boiled to make a light-brown dye for handicraft fibers, such as *Triumfetta*, *Hibiscus*, and young coconut leaf, but not for *Pandanus*.

Scaevola frutescens (Mill.) Krause. "Kōnnat." A shrub or small tree, the wood of which is used for the curving booms of the outrigger; also for the roof frame of a house. The leaf is used to make a bitter drink which is given to a pregnant woman just before and just after childbirth ("to clean up the belly inside"); it is also used to wash the mother's body.

Mason also obtained notes on other species not collected on the excursion but known to be common to Kili and Bikini. Since they are known by the same vernacular names on the other Marshall Islands, it is possible to identify them with surety. These are:

Artocarpus incisus L. f. "Mā." Two varieties exist: "betaktok," the fruits of which are large and seedless and make excellent food; and "mejwan," the fruits of which are seed-bearing.

Hernandia ovigera L. "Bing bing." A tree, used for canoe hulls.

The three Bikinian informants also told of eight other plants characteristic of Bikini but not occurring on Kili. For each they furnished the vernacular name and a description. By use of these we have identified six of them. They are:

Portulaca samoënsis v. Poelln. "Bujang." "A low bush." In Taylor's book this is listed as *P. quadrifida* L., the valid name of an African species, but we consider it a misidentification of the Pacific species.

Cassytha filiformis L. "Kanōn." "A leafless vine which kills the trees on which it grows."

Sophora tomentosa L. "Kille." "A tall tree, about 15 to 20 feet high."

Suriana maritima L. "Kalange." "Somewhat like 'konge' (*Pemphis acidula*) but smaller."

Euphorbia Atoto Forst. f. "Berrol." "A low bush, with small leaves, which when cut exudes a milky juice." Taylor (1950: 3) stated that members of the Euphorbiaceae do not occur on Bikini or the northern Marshalls, but this species and three other members of the family are now known to occur on Eniwetok, so this report is credible.

Sida fallax Walp. "Kio." "A bush with a yellow flower."

Of the list of eight species named and described, there remain two which we have not identified:

"Kōra." "A bush about two feet high, with leaves like 'nen kōtkōt' (*Fleurya ruderalis*), but larger."

"Kāliklik." "A thorny bush." The name "kailiklik" is regularly used in the Marshalls for a cultivated variety of *Cyrtosperma Chamissonis* that has prickly petioles, but that does not seem to be the right application of it here. The vernacular name means thorny or prickly. On Bikini this name might be applied to *Achyranthes canescens*, which is prickly enough to deserve the description.

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The Relationship Between Body Length and Scale Length in Five Year-Classes of the Pacific Pilchard or Sardine, *Sardinops caerulea* (Girard, 1854).

ANTONIO LANDA[1]

INTRODUCTION

BY CORRELATING the marginal growth of scales (the amount of growth between the last ring or annulus and the margin of the scale) with the season of the year in which the scales were collected, Walford and Mosher (1943*a*: 9 and 1943*b*: 12) have shown for the Pacific pilchard or sardine, *Sardinops caerulea* (Girard) 1854, that these rings are formed annually and consequently can be used for age determination as well as for back-calculation of the length of the fish at a given earlier age. The application of the scale rings to the problem of age determination in the pilchard has been thoroughly discussed in the papers cited above. The application of the same phenomenon to back-calculation of lengths, which lengths are used in several different types of problems, requires further consideration. The literature on this subject is voluminous and of considerable interest. Reference should be made to the works of Blackburn (1949), Buchanan-Wollaston (1934), Lea (1910, 1913), Lee (1912), Ottestad (1938), and Schuck (1949) for further information.

The estimation of body length at a previous age, using length of the scale from its center to the ring corresponding to that age, involves the regression of body length on scale length. The regression of scale length on body length, sometimes used, will give the mean scale length corresponding to a given body length, information which is not pertinent to the problem. It should be noted at once that different regression lines could be obtained from a given set of material depending on the manner of sampling and that this manner, in turn, depends on the use for which the regression values are intended. Thus, if the goal is to know at which body length the scales start growing, it should be emphasized that the sampling be comprehensive of the very small body lengths. Moreover, such sampling should be equally representative of all the body lengths if a further goal is desired, i.e., to know whether or not the regression of body length on scale length is the same throughout all different body lengths.

In the particular case of the Pacific pilchard investigations, and, presumably, in others of similar commercial fisheries, the goal is to know the body lengths that the fish caught commercially had in previous years. It follows that the sampling should, before anything else, be representative of the commercial catch even if that requirement makes the data unsuitable for the attainment of goals of the type indicated above. Once the scope of the problem is thus limited, the following are some of the questions that arise in the back-calculation and use of estimated lenghts:

(1) Are the regression constants (regression coefficient and body intercept) of body length on scale length the same for all year-classes regardless of region of capture?

(2) Are the regression constants for a given year-class the same regardless of region of capture?

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(3) Can the regression of body length on scale length be expressed by a straight line when fish of successive ages are considered?

(4) If the regression is linear, does it have its origin at 0.0? (If so, the actual process of calculating lengths at previous ages may be greatly simplified.)

Answers to these four questions are necessary in order to decide if, for back-calculation of lengths, a given body of data should be treated as a unit or grouped by year-classes, by regions in which the fish were captured, by age groups, or by groups combining two or three of these categories.

Acknowledgments

I wish to thank Mr. John C. Marr, Dr. Frances E. Felin, and Mr. Theodore M. Widrig of the U. S. Fish and Wildlife Service for making the material used in this study available to me and for other assistance.

SOURCE OF DATA

Material with which to investigate these questions consists of records of scale readings for the Pacific sardine on file at the laboratory of the South Pacific Fishery Investigations, U. S. Fish and Wildlife Service, at Stanford University. The material was obtained as a result of a co-operative program between the U. S. Fish and Wildlife Service, the California Department of Fish and Game, the Fisheries Research Board of Canada, the Washington State Department of Fisheries, and the Fish Commission of Oregon. The methods of collecting samples, examining scales, and recording data are explained by Felin and Phillips (1948). In brief, each fish is represented by a card which contains information on fish length, sex, date and locality of capture, and, on a printed scale, the relative position of the focus, annuli, and margin of the fish scale. The data are, in general, representative of the populations commercially fished along the Pacific Coast of the United States and Canada (with the exception of bait fisheries in southern California).

From the material available (about 60,000 cards), the data for the 1938 through 1942 classes for fish caught off Canada, Washington and Oregon, San Francisco, Monterey, and San Pedro during the fishing seasons of 1939–40 through 1947–48 were selected in order to have (1) a series of year-classes represented, (2) all the commercial ports represented (3) for each year-class, fish with one to five annuli represented.

METHODS

To reduce this material (about 40,000 cards) to workable proportions and still have a representation of the fish taken by the commercial fishery, a sample was taken in the following manner:

(1) All the cards belonging to the material selected were considered as a single "population" without regard to year-class, port of landing, age, or season of the year in which the fish were caught.

(2) One thousand one hundred and ninety-nine bibliographic cards (about 3 per cent of the above population) were marked with numbers taken from a random numbers table (Table 1 in Dixon and Massey, 1949) using five-digit numbers. The cards were arranged in ascending order. Three percent was chosen because, after some trials, it was seen to be the minimum number of cards likely to include every category in the sample.

(3) The scale reading cards were counted, and, when the count coincided with the number on the first bibliographic card, the latter was removed, and the corresponding scale card was taken as part of the sample. This process was repeated, without interrupting the original count, until all the bibliographic cards were removed.

(4) The sample so obtained was then subdivided into all possible year-class and port combinations. By chance, the

TABLE 1

CODED VALUES TAKEN FROM SCATTER DIAGRAMS
(Y = Body Length; X = Scale Length)

YEAR-CLASS AND PORT COMBINATION	nj*	Y′†	Y′²	X′‡	X′²	X′Y′
1938 in:						
Pacific						
Northwest...	10	−29	1015	14	88	91
San Francisco..	91	−16	4514	79	843	1138
Monterey.....	76	269	4371	26	640	938
San Pedro.....	60	−26	1692	−32	374	549
1939 in:						
Pacific						
Northwest...	43	138	5472	−33	349	807
San Francisco..	150	1079	27721	16	2302	5388
Monterey.....	166	640	15716	−63	1541	2620
San Pedro.....	124	−128	4926	54	716	1065
1940 in:						
Pacific						
Northwest...	14	25	1681	22	45	96
San Francisco..	50	−12	2120	−4	368	430
Monterey.....	75	487	12303	93	1111	2639
San Pedro.....	70	−109	3823	−23	535	1091
1941 in:						
San Francisco..	5	−4	102	3	37	15
Monterey.....	26	125	3171	42	274	726
San Pedro.....	90	153	2923	90	484	809
1942 in:						
Pacific						
Northwest...	7	61	1415	6	84	270
San Francisco..	23	16	1531	6	192	204
Monterey.....	68	491	12327	159	1283	3464
San Pedro.....	51	−6	4486	10	502	1308

*n_j = number of items in jth group.
†Y′ = sum of coded body lengths.
‡ X′ = sum of coded scale lengths.

1941 year-class in the Pacific Northwest did not appear in the sample.

For each year-class and port combination a two-variable frequency table was made, plotting standard body lengths against scale lengths. Body lengths were grouped by 2-millimeter intervals, scale lengths by 6-millimeter intervals. In order to code, arbitrary means were independently chosen for each of the variables in every frequency table. Owing to the magnification used in reading the scales, the scale-length values are 30 times larger than the actual scale lengths (Felin and Phillips, 1948).

The values obtained from these frequency tables are given in Table 1. It is possible to pool these values in such a way as to obtain combinations other than port and year-class combinations. For example, to obtain information about the 1938 class as a unit, the sums of X′ for the 1938 class from all ports are pooled in a single sum, the sums of Y′ are similarly pooled, etc.

TABLE 2

VALUES USED IN THE COVARIANCE TESTS

TEST	S_1	S_2	S_3	S_4	N*	p†
1	53941	1046	646	125	1199	5
2	6631	26	882	1162	237	4
3	21828	292	1522	18	483	4
4	9154	392	421	2351	209	4
5	2899	175	30	405	121	3
6	5542	401	279	322	149	4

* N = total number of observations.
† p = number of groups.

Pooled data obtained in this manner were used to get the S_1, S_2, S_3, and S_4 values (see Table 2) as defined in Kendall (1946: 238 ff.) to make the tests indicated in Table 3. Tests were made after Kendall (*op. cit.*), at the .05 level of significance and each consisted of testing the hypotheses (1) that the regression coefficients of the subclasses considered could have been drawn from the same populations and (2) that the regression of body length on scale length was a straight line (see footnote to Table 3). They were performed with coded data; later the data were uncoded to calculate the means, deviations, regression coefficients of body length on scale length, and body-length intercepts for the groups that were shown, by the tests, to be significantly different. Test 1 indicated that the hypothesis (1) above should be rejected, and therefore it was necessary to consider each year-class separately.

RESULTS

From the results of Tests 1 to 6 (Table 3) and from the values found (Table 4), the questions posed can be answered, as far as the material treated is concerned, as follows:

TABLE 3

COVARIANCE TESTS FOR THE REGRESSION OF BODY LENGTH ON SCALE LENGTH

TEST	DATA COMPARED	HYPOTHESES	STATISTIC*	F. RATIO* (.05 l. of s.)
1	1938, 1939, 1940, 1941, and 1942 year-classes, ages 1–5, data pooled from all ports.	For all the data, the relationship can be expressed by a straight line.	.19	2.93
		No difference between the regression coefficients of each year-class.	5.76	2.37
2	1938 class in: Pacific Northwest San Francisco Monterey San Pedro	For all the data, the relationship can be expressed by a straight line.	.84	3.67
		No difference between the regression coefficients of the 1938 class in each port.	.30	2.60
3	1939 class in: Pacific Northwest San Francisco Monterey San Pedro	For all the data, the relationship can be expressed by a straight line.	.15	3.67
		No difference between the regression coefficients of the 1939 class in each port.	2.12	2.60
4	1940 class in: Pacific Northwest San Francisco Monterey San Pedro	For all the data, the relationship can be expressed by a straight line.	.09	3.67
		No difference between the regression coefficients of the 1940 class in each port.	2.87	2.60
5	1941 class in: San Francisco Monterey San Pedro	For all the data, the relationship can be expressed by a straight line.	.16	5.66
		No difference between the regression coefficients of the 1941 class in each port.	3.47	3.07
6	1942 class in: Pacific Northwest San Francisco Monterey San Pedro	For all the data, the relationship can be expressed by a straight line.	.23	3.67
		No difference between the regression coefficients of the 1942 class in each port.	3.40	2.60

* Statistic to test if the relationship can be expressed by a straight line:

$$\frac{S_1}{N-2p} \cdot \frac{2p-2}{S_2+S_3+S_4}$$ to be compared with F. ratio: $$\frac{N-2p}{2p-2}$$

Statistic to test if there is difference between the regression coefficients of the subclasses involved:

$$\frac{S_2}{p-1} \cdot \frac{N-2p}{S_1}$$ to be compared with F. ratio: $$\frac{p-1}{N-2p}$$

(1) The coefficient of regression of body length on scale length and the body intercept are significantly different for the 1938, 1939, 1940, 1941, and 1942 classes (Test 1).

(2) There is no significant difference among the regression constants for the whole 1938 class regardless of area of capture (Test 2). The same is true for the 1939 class (Test 3). The regression constants for the 1940 class are significantly different for fish sampled in the Pacific Northwest, San Francisco, Monterey, and San Pedro (Test 4). This also is true of the 1941 class (Test 5) and the 1942 class (Test 6).

(3) The relationship between body length and scale length for 1- to 5-ring fish of the year-classes involved does not

TABLE 4
REGRESSION VALUES FOUND FOR HOMOGENEOUS GROUPS

GROUPS	N*	$b_{y.x}$†	s_x‡	s_y§	r‖	$s_{y.x}$¶	$s_{b_{y.x}}$**	Y.††	X.‡‡	a§§	(Y)‖‖	(X)¶¶
1938 year-class.....	237	15.90	.58	14.42	.64	11.1	1.24	210	5.20	127	202	124
1939 year-class.....	483	21.90	.70	19.89	.77	12.7	.85	211	5.17	98	204	154
1940 year-class in:												
Pacific Northwest.	14	57.00	.17	22.43	.43	20.3	32.54	226	5.76	−102	222	164
San Francisco.....	50	11.66	.54	13.14	.479	11.5	3.01	227	5.65	161	228	170
Monterey.....	75	20.45	.73	22.23	.67	16.4	2.60	213	5.30	105	200	152
San Pedro.....	70	21.38	.55	14.56	.81	8.5	1.86	201	5.00	94	204	152
1941 year-class in:												
San Francisco.....	5	5.00	.55	10.00	.28	9.6	8.10	220	5.80	191	222	170
Monterey.....	26	25.36	.57	20.28	.71	14.3	4.99	210	5.40	73	200	152
San Pedro.....	90	16.64	.42	10.94	.64	8.4	2.10	199	5.06	115	196	146
1942 year-class in:												
Pacific Northwest.	7	28.00	.72	24.20	.83	13.5	7.63	233	5.63	75	216	164
San Francisco.....	23	10.50	.58	16.62	.37	15.4	5.65	217	5.53	159	216	164
Monterey.....	68	25.40	.73	22.89	.81	13.3	2.20	200	5.13	70	186	140
San Pedro.....	51	26.20	.60	18.94	.83	10.5	2.35	202	5.10	68	202	152

* N = number of items in the group.

† $b_{y.x}$ = regression coefficients of y on x = $\dfrac{N\Sigma X'Y' - (\Sigma X')(\Sigma Y')}{N\Sigma X'^2 - (\Sigma X')^2}$

[For actual calculation the uncoded values were used: $X' = (X') - 30X$; $Y' = (Y) - Y$]

‡ s_x = standard deviation of mean scale length = $\dfrac{1}{5}\sqrt{\dfrac{\Sigma X'^2 - \dfrac{(\Sigma X')^2}{N}}{N-1}}$

§ s_y = standard deviation of mean body length = $\dfrac{1}{2}\sqrt{\dfrac{\Sigma Y'^2 - \dfrac{(\Sigma Y')^2}{N}}{N-1}}$

‖ r = correlation coefficient = $\dfrac{s_x}{s_y} b_{y.x}$

¶ $s_{y.x}$ = standard error of estimate = $s_y(1-r)$

** $s_{b_{y.x}}$ = variance of regression coefficient = $\dfrac{s_{y.x}}{s_x\sqrt{N-1}}$

†† Y. = mean body length = $\dfrac{\Sigma Y'}{N}$ + assumed mean of Y

‡‡ X. = mean scale length = $\dfrac{\Sigma X'}{N}$ + assumed mean of X

§§ a = body intercept = Y.−bX.

‖‖ (Y) = assumed mean of Y

¶¶ (X) = assumed mean of X

$\dfrac{}{30}$

deviate significantly from a straight line (Tests 1 to 6 and Table 4).

(4) The values found for the y-intercepts are so great that it seems likely that the regressions do not pass through the origin (0.0) although this was not tested.

These answers imply that, in order to back-calculate lengths, the formula 1n = a + bsn (in which 1n = body length at age n and sn = scale length at age n) should be used in which, for each homogeneous group, the values of "a" and "b" are different (see Table 4). These values are used in a separate work for a study of the rate of deceleration of growth in the Pacific sardine. It should be noted that the formula given above, which applies to averages, suits our purpose quite well as long as

our sample is reasonably representative of the commercial catch; also, that its use avoids an error likely to be introduced when only the individual relationship, body length–scale length, is used, i.e., the error caused by the use of scales of different parts of the body.

SUMMARY AND CONCLUSIONS

To determine what method will most accurately serve to back-calculate lengths of pilchard at earlier ages, covariance analysis of observed scale and body-length regressions is useful. Emphasis is given to the most appropriate sampling criteria to be used in order to get the regression values, as well as to the actual method of sampling.

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A New Terrestrial Isopod from Oregon, *Caucasonethes rothi* n. sp.

A. VANDEL[1]

Mr. Vincent D. Roth, Technician and Curator, Entomology Department, Oregon State College, captured a specimen of a remarkable terrestrial isopod 8 miles east of Gold Beach, Oregon. Upon the suggestion of Dr. Robert J. Menzies, San Diego, California, Roth sent me this specimen for determination.

This specimen belongs to the genus *Caucasonethes* Verhoeff, and to a new species, named *C. rothi* n. sp. in honor of the discoverer.

The genus *Caucasonethes* belongs to the family Trichoniscidae and to a group of genera which includes *Protrichoniscus* Arc., *Caucasonethes* Verh., *Escualdoniscus* Vand., and *Finaloniscus* Brian (and, perhaps, *Brackenridgia* Ulrich, still imperfectly known).

GENERIC CHARACTERS OF CAUCASONETHES VERHOEFF 1932

I consider today that *Amerigoniscus* Vandel 1950 is a synonym of *Caucasonethes* Verhoeff 1932. The generic characters of *Caucasonethes* are the following:

(1) Pleonites 4 and 5 destitute of glandular pores.

(2) Peraeopod VII without secondary sexual characters.

(3) Endopodite of pleopod 1 male unisegmented, likened to a lengthened triangular blade, destitute of terminal bristles.

(4) Exopodite of pleopod 1 male with posterior end split into two lobes.

(5) Endopodite of pleopod 2 male bisegmented; distal article terminating in an acute and short point.

SPECIES OF THE GENUS CAUCASONETHES

The genus *Caucasonethes* includes three species: *borutzkii* Verhoeff 1932 (caves of Kutais and Zchal-Ziteli, in Transcaucasus; Birstein, 1950: 356); *henroti* (Vandel, 1950) (*Amerigoniscus*) (Gilly's Cave, Pennington Gap, Virginia); and *rothi* n. sp.

The three species are very near one another but are easily distinguishable thus:

1. Endopodite of pleopod 1 male 8 times longer than broad, rounded at tip . . . . . *henroti* (Vandel)
   Endopodite of pleopod 1 male 10 times longer than broad, acute at tip 2
2. Exopodite of pleopod 1 male with 2 acute terminal lobes, widely separated from each other . . . . . *borutzkii* Verhoeff
   Exopodite of pleopod 1 male with 2 terminal approximated lobes, one quadrangular, the other triangular . . *rothi* n. sp.

Caucasonethes rothi n. sp.

TYPE LOCALITY: Eight miles east of Gold Beach, Oregon, on the north bank of the Rogue River, under brocken rock and moss in a dense forest, April 29, 1951, V. Roth collector. 1 ♂. The type is deposited in the collection of the author.

SIZE: ♂, 5.5 × 2 mm.

COLORATION: White; without pigment.

EYES: absent.

TEGUMENTAL CHARACTERS: Surface of head with 4 rows of granulations, the last one consisting of strong, projecting tubercles. Tergite I with 3, tergites II–VII with 2 rows of granu-

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lations, last one strongest. Granulations of last segments much weaker than those of anterior segments. Some weak granulations upon pleonites 1–3. Every granulation covered with a bristle-scale (*Schuppenborste* of German authors) surrounded with numerous accessory scales (Fig. 1*a*).

Carapace covered with laciniate scales.

Pleonites 4–5 without glandular pores.

SOMATIC CHARACTERS: Antennary tubercles of cephalon, large triangular, projecting forward.

Tip of telson rounded, with 4 bristles (Fig. 1*g*).

APPENDAGES: *Antennula* (Fig. 1*c*)—3-segmented, last article with 10 sensory hairs (*aesthetascs*).

Antenna (Fig. 1*d*)—long; articles 2, 3, and 4 grooved; articles 4 and 5 with 3 rows of scaly tubercles. Flagellum 6-segmented; articles 2, 3, and 4 with sensory hairs (*aesthetascs*).

Right mandible (Fig. 1*f*)—2 median penicills and 1 molar penicill.

Left mandible—(?), crushed.

Maxillula—outer endite (Fig. 2*b*) terminated with 11 teeth and 2 stalks, one long and cylindrical, the other short and feathered.

Maxilliped (Fig. 2*a*)—palp 4-segmented; only first article individualized. Tip of endite terminated with 3 strong bristles and conical, ciliated spindle.

Peraeopods—normal, long and slender.

Pleopod 3—exopodite quadrangular.

Pleopods 4 and 5—exopodite triangular.

Uropod (Fig. 1*e*)—endopodite a little shorter and very much narrower than exopodite, terminated with a very long stalk; exopodite with cluster of short stalks.

SECONDARY SEXUAL MALE CHARACTERS:

Peraeopod I—meros and carpos fringed with hyaline scales.

Peraeopod VII—destitute of sexual differences.

Genital duct (*Genitalkegel* of German authors) (Fig. 2*e*)—very long, narrow, conical at tip.

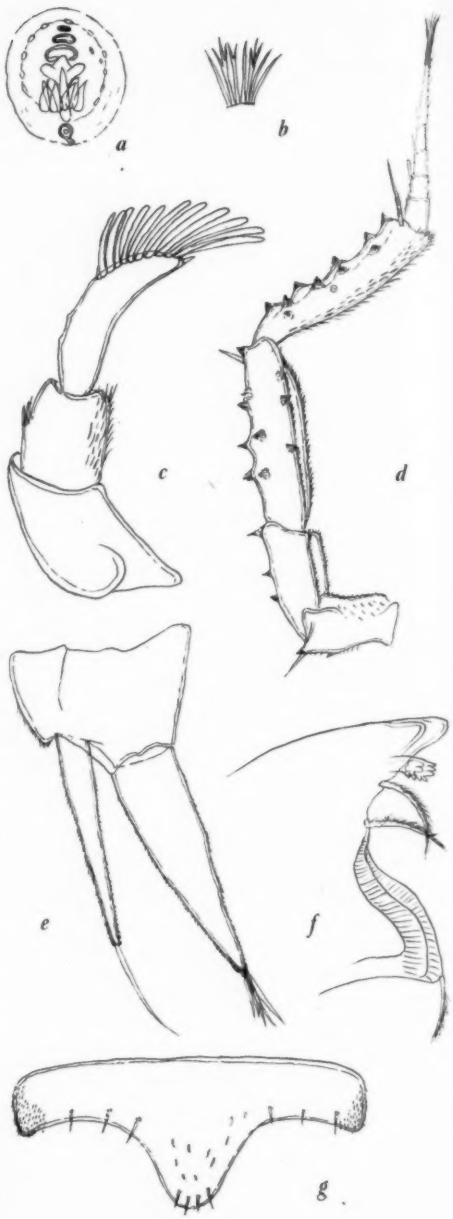

FIG. 1. *Caucasonethes rothi* n. sp.: *a*, Bristle-scale of tergite I; *b*, laciniate scale of carapace; *c*, antennula; *d*, antenna; *e*, uropod; *f*, right mandible; *g*, telson.

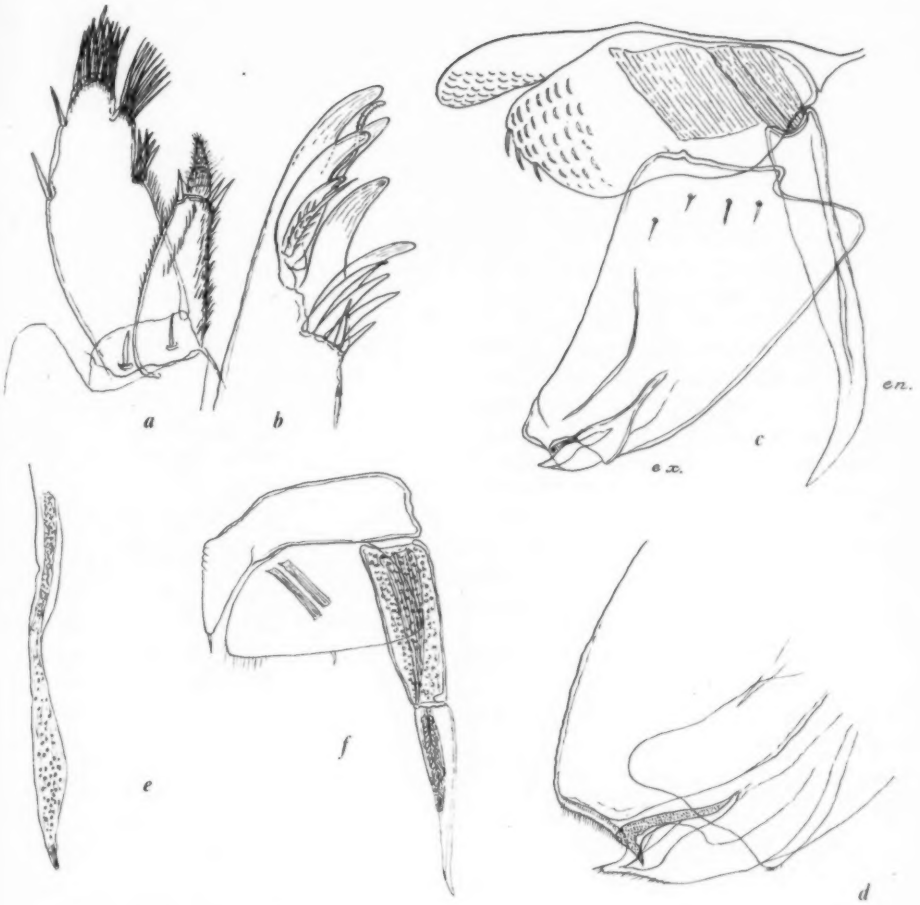

FIG. 2. *Caucasonethes rothi* n. sp.: *a*, Maxilliped; *b*, maxillula, end of the outer endite; *c*, first pleopod of male, *en*—endopodite,*ex*—exopodite; *d*, posterior end of exopodite of first pleopod of male; *e*, genital duct; *f*, second pleopod of male.

Pleopod 1 (Figs. 2*c*, *d*)—endopodite blade-like, triangular, very narrow and lengthened, destitute of terminal stalk. Exopodite large, quadrangular, terminated with 2 lobes, one quadrangular and ciliated, the other triangular and pointed.

Pleopod 2 (Fig. 2*f*)—endopodite bisegmented, sharpened at end; exopodite rectangular.

RELATIONSHIP OF CAUCASONETHES ROTHI N. SP. AND OREGONISCUS NEARCTICUS (ARCANGELI)

Arcangeli (1932: 137) gave the name of *Trichoniscus nearcticus* to a single female from MacLeay Park, Portland, Oregon. Hatch (1947: 190) proposed the generic name *Oregoniscus* for this species.

It is difficult to recognize the species of terrestrial isopods based only upon females, but, I think that *Oregoniscus nearcticus* (Arcangeli) and *Caucasonethes rothi* n. sp. are distinct. They differ in many points:

(1) The size is very different: *O. nearcticus*, 2.73 mm. long; *C. rothi*, 5.5 mm. long.

(2) The number and disposition of sensory hairs (*aesthetascs*) of antennula is very different in the two species.

(3) Antennae very long in *C. rothi*, short in *O. nearcticus* "caratteristica è la incavatura che dorsalmente presenta nelle metà distale esterna il 5° articolo dello scapo" (Arcangeli, 1932). This character is missing in *C. rothi*. The flagellum of the antenna is six-segmented in *C. rothi*, four-segmented in *O. nearcticus*.

(4) The legs of *C. rothi* are long and slender, whereas in *O. nearcticus* "è da notarsi la larghezza e relativamente piccola lunghezza specialmente del meropodite, carpopedite, e propodite, che conferiscono al membro un aspetto massiccio" (loc. cit.).

(5) In *C. rothi* the endopodite of the uropod is only a little shorter (about one tenth) than the exopodite. In *O. nearcticus*, the endopodite is about one half as long as the exopodite.

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Floristic Interchanges Between Formosa and the Philippines

HUI-LIN LI[1]

INTRODUCTION

THE FLORAS of Formosa and the Philippines are, in spite of their geographic proximity, distinctive in their general nature. The two regions were separated by the Formosan rift (the Bashi Channel), probably in the early Tertiary, long before their connections with other respective neighboring areas were severed. Thus the bulk of the Formosan flora was derived from China or from other floras that spread to Formosa through the Chinese mainland, while the bulk of the Philippine flora was derived from Malaysia and other lands south of the Asiatic continent.

The distinctiveness of the two floras has been amply demonstrated by Merrill (1923). It will suffice to mention here the many tropical and southern families that are present in the Philippines but absent from Formosa, such as the Dipterocarpaceae, Centrolepidaceae, Monimiaceae, Nepenthaceae, Cunoniaceae, Erythroxylaceae, Dichapetalaceae, Datiscaceae, Clethraceae, Epacridaceae, and Salvadoraceae. On the other hand, many other families, clearly of northern origin, occur in Formosa but are entirely absent from the Philippines, such as Cephalotaxaceae, Taxodiaceae, Cupressaceae, Betulaceae, Lardizabalaceae, Trochodendraceae, Papaveraceae, Geraniaceae, Callitrichaceae, Pyrolaceae, Diapensiaceae, Valerianaceae, and Dipsaceae.

However, though the basic constituents of the two floras are quite different, indicating their separate origins, their close geographic proximity allows certain floristic interchanges, apparently of relatively recent times. The distance between the main islands, Formosa and Luzon, is about 350 kilometers. Stretching in the sea between the two is a chain of small islands, parts of the same volcanic line. The first group consists of three islands off the southeastern coast of Formosa, Hoshaotao (Kotosho in Japanese), now called Lutao, Hungtauyu (Katosho in Japanese), now called Lanyu and commonly known as Botel Tobago, and the tiny island, Little Botel Tobago. These islands are separated from the Batan (or Batanes or Bashi) Islands by the Bashi Channel at a distance of about 100 kilometers. The Batan Islands are separated from the Babuyan Islands, which are close to the northern coast of Luzon, by the Balintang Channel, about 70 kilometers wide. The distance is nowhere great enough to make plant migration difficult. At South Cape, the southernmost tip of Formosa, the small island Y'Ami of the Batan group, the northernmost of the Philippine Islands, is actually within sight.

These small islands show remarkable affinities with the Philippine flora, even the northernmost ones, Lutao and Lanyu, which are closest to Formosa. The conspicuous relationship of the floras and faunas of the two latter islands to the Philippines has led some to suggest extending the Neo-Wallace Line northward from the Philippines, passing it between the main island of Formosa and these

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two small islands (Kano, 1931). However, it has been shown that the southern tip of Formosa, commonly known as the Hunchuen (Koshun) Peninsula, has a flora quite distinct from that of the Formosan mainland but very close to that of these two small islands, showing similarly distinctive relationships with the Philippine flora. There is a marked infiltration of austral elements from the Philippines to Formosa, particularly in the extreme southern part of the island and in these two small islands (Li and Keng, 1950).

SOUTHWARD MOVEMENT OF TEMPERATE ELEMENTS

Before the inception of this northward migration of relatively recent occurrence, as will be discussed later, there occurred another expansion of floristic elements in the opposite direction, that is, from Formosa to the Philippines. These elements, in contrast to the southern tropical elements, mostly of the lowlands, are cold–temperate in nature and limited to montane or alpine regions. In Formosa, because of the massive and lofty mountain ranges which occupy most of the central portion of the island, there developed an extensive alpine-montane flora rich in number of species. These plants show distinctively close relationships with those of western China and the eastern Himalayas and also to some extent with the montane flora of Japan in the north.

There are over 40 peaks in the Formosan mountain systems that exceed 1,000 meters in height. The highest peak is Yu Shan, or Mt. Morrison, towering to a height of 1,950 meters, the highest of all eastern Asia. Such an extensive, high mountain chain permits the existence of an alpine flora that otherwise exists only in the Himalayas, western China, and other mountain regions far north of Formosa.

From Formosa, a large number of temperate elements, mostly of mountain regions, extend southward to the Philippines. In the Philippine Islands, these Asiatic elements are largely confined to medium and high altitudes in northern Luzon. Such characteristically northern or Asiatic elements, mostly common genera in the mountains of Formosa, such as *Lilium*, *Liriope*, *Saururus*, *Thesium*, *Arenaria*, *Sedum*, *Deutzia*, *Rosa*, *Skimmia*, *Buxus*, *Pistacia*, *Androsace*, *Hoppea*, *Salvia*, *Ellisiophyllum*, *Hemiphragma*, *Peracarpa*, *Aster*, *Solidago*, *Anisopappus*, and *Artemisia*, occur nowhere in the Malayan region outside of northern Luzon (Merrill, 1923–26). It is apparent that Formosa is an important route of migration of these Asiatic types to the regions in the south (Van Steenis, 1946).

We may picture that during the Pleistocene or earlier, when the general temperature was much lower than now, these montane species would have inhabited lower elevations and thus had greater ranges. Their ranges might have been more or less continuous, extending from the Himalayas and western China through the mountains of southern China to Formosa and Luzon. Subsequent rising of temperatures forced these plants to higher elevations until finally they occupied the present isolated mountain regions suitable for their existence. Thus, species like *Hemiphragma heterophyllum* Wall. and *Ellisiophyllum pinnatum* (Wall.) Makino now have widely disjunct ranges on the high mountains of Luzon, Formosa, western China, and the eastern Himalayas, etc.

These Philippine plants of northern origins are sometimes specifically or subspecifically distinct from their congeners in Formosa, while others may be specifically identical. That some of these show morphological differentiation indicates that their separation must have been for a considerable length of time. As such plants are now confined to isolated and distant mountain regions and as there were drastic changes in climate during the geologically recent past, such a southward migration of the montane flora may be considered largely a matter of the past, there being little possibility that the same process is going on extensively at the present.

NORTHWARD MOVEMENT OF TROPICAL ELEMENTS

In contrast to the southward migration of these temperate elements, the northward movement of tropical elements from the Philippines to Formosa is limited practically to the lowlands and particularly to the southern extreme of the island of Formosa. Favored by the gradual rising of temperature since the Pleistocene, these tropical, or southern, plants that find their way to Formosa are able to establish themselves there.

Apparently many strand plants migrate by the help of ocean currents. In the case of Formosa, the main current is supplied by the Japan Stream from the south which passes along the island chain connecting the Philippines and Formosa. This chain of small islands also acts as a series of stepping stones for the migration of plants, especially from south to north. This northward migration of plants is also aided by wind. The prevalent monsoon during the summer and fall and the general track of typhoons rampant in the eastern Pacific during this same period of the year are also in a northeastern direction from the tropics, often leading from the Philippines to Formosa.

That these islands serve as an efficient migration route of the northward movement of southern plants can be demonstrated by the presence of the following floral elements in Formosa: (1) species of wide tropical distribution, (2) species common to the Philippines and Formosa, (3) species common to the Philippines and the southernmost part of Formosa, and (4) species common to the Philippines and the islands of Lutao and Lanyu.

In the first group are many paleotropic species that extend to the whole island of Formosa but more commonly only to the southern part of the island. Such common species are *Dodanea viscosa* (L.) Jacq., *Croton cumingia* Muell.-Arg., *Litsea cubeba* Pers., and *Murrya paniculata* (L.) Jack. Those that also occur in the northern part are mostly along the coastal lowlands. Their wide ranges are due apparently to their more aggressive nature and especially to their wider tolerance of temperature extremes.

In the second group are species like *Acacia confusa* Merr., *Ipomoea polymorpha* R. & S., and *Oreocnide trinervis* Wedd., which occur widely in the Philippines and extend also to Formosa, especially along the coasts and lowlands, from south to north. The number of such species with wide ranges in Formosa is few, indicating the insignificance of such elements and possibly also their recent and scattered arrival.

There are many more species common to the Philippines and Formosa but confined in the latter island to the southern part. These species are sometimes limited only to the southernmost tip of the island—the Hunchuen Peninsula and the small islands of Lutao and Lanyu. Such species as *Illigera luzonensis* Merr., *Schizostachyum diffusum* Merr., *Goniothalamus amuyon* Merr., *Aglaia elliptici-folia* Merr., *Maba buxifolia* Pers., *Guettarda speciosa* L., *Morinda citrifolia* L., *Pemphis acidula* Forst., etc., are often important elements in the local vegetation. That their occurrence is often limited to the seashore and coastal areas in Formosa distinctly indicates that they are relatively recent arrivals.

The flora of the two small islands, Lutao and Lanyu, off the southeast coast of Formosa is much more intimately related to the southernmost part of Formosa than is generally understood (Li and Keng, 1950). The southernmost tip of Formosa manifests close floristic relationships with the small islands as well as with the Philippines in general. Its flora is quite distinct from that of northern Formosa. The fact that some species are present on these two small islands but absent in the southernmost part of Formosa is due apparently to human factors, as the mainland of Formosa has been more severely exploited. As a result, there are a number of Philippine species that are present on these islands but do not occur on the mainland of Formosa, such as *Myristica cagayanensis* Merr., *Boerlagiodendron pecti-*

natum Merr., *Dysoxylum cumingiana* DC., *Styrax kotoensis* Hay., *Turpinia lucida* Nakai, *Macaranga dipterocarpifolia* Merr., etc.

The importance in floristic migration played by the chain of small islands between the Philippines and Formosa can be illustrated more precisely by a few cases. Among the wide paleotropic species, chiefly along or near the coast and common throughout the Philippine Islands, are *Morinda citrifolia* L. and *Maba buxifolia* (Rott.) Pers. (= *Diospyros ferrea* Bakh.). These species extend through the Batan and Babuyan Islands to Formosa, limited in the latter case only to Lutao and Lanyu and the southernmost Hunchuen Peninsula. Among the less wide species are *Aglaia formosana* Hay. and *A. ellipticifolia* Merr., both of the northern part of Luzon. These species also extend northward, following the same route, through the Batan and Babuyan Islands to Hunchuen Peninsula in Formosa and to Lutao and Lanyu.

That these southern tropical elements are relatively recent arrivals in Formosa can be attested by their occurrence in coastal regions and in secondary forests as well as by their specific identity with Philippine plants. In most cases, the species in Formosa are exactly the same as in the Philippines. These species have not been isolated long enough to have undergone any morphological differentiation. It may be presumed that this northward migration is not only very recent but is still continuing at the present. Success of establishment of these southern species in Formosa is controlled mainly by climate factors. With probable continued rise of temperature in the future, there may be more southern species entering into the flora of Formosa. At the same time, many of the species will be able to extend their range to the northern part of the island.

SOME FLORISTIC NOTES

In the past, this southern affinity of the Formosan flora has not been properly emphasized because of our inadequate information. The floras of Formosa and the Philippines have been studied, in most cases, independently of one another. Many of the species proposed from Formosa are later found to be conspecific with earlier-named Philippine species. Such scattered findings are increasing in number. More recently, with ample reference collections from the Philippine Islands at hand, the present writer restudied many Formosan plants in connection with related species from neighboring regions. It was discovered that many species, especially those considered endemic to southern Formosa or Lanyu (Botel Tobago), are synonymous with certain generally widespread species of the Philippine Islands, especially of Luzon and the northern small islands. Some of these notes have been published in a few scattered papers (Li, 1950, 1952). A number of recent findings are enumerated below. Cited specimens are selected from the herbarium of the National Taiwan University, Formosa (NTU), and the U.S. National Herbarium, Smithsonian Institution (US).

Urticaceae

1. **Laportea batanensis** C. B. Robinson in Philip. Jour. Sci. 5. Bot.: 481, 1910.
   Laportea kotoensis Hay., Gen. Ind. Fl. Formos. 70, 1916, nomen; Kanehira, Formos. Trees 529, 1917; *ibid.*, rev. ed. 170, 1936. *Syn. nov.*
   Batan Islands, Botel Tobago.

Neither Hayata nor Kanehira cited specimens, but Kanehira's very brief description shows that the plant is identical to the Philippine species, *L. batanensis*, known from the Batan Islands only.

Myristicaceae

1. **Myristica cagayanensis** Merr. in Philip. Jour. Sci. 17: 255, 1920; Kanehira, Formos. Trees rev. ed. 193, f. 141, 1926.
   Myristica glomerata Kudo & Masamune in Ann. Taihoku Bot. Gard. 2: 89, 1932. *Syn. nov.*

Luzon; Formosa, in southern part, and in Botel Tobago.

Formosa: Cuntin, Hunchuen Peninsula, *H. Keng*, Oct. 31, 1950 (US).

Myristica glomerata Kudo & Masamune is a name based on *Sterculia glomerata* Blanco, Fl. Filip. ed. 1. 764. 1837, which had earlier been made into the combination *Knema glomerata* (Blanco) Merr. in Jour. Str. Branch. Roy. As. Soc. 76: 81. 1917, Sp. Blanco. 151. 1918, a species of Borneo and the Philippines but not of Formosa. Kudo and Masamune were misled by the previous misidentification of the Formosan plant in question as *Myristica heterophylla* sensu Hay., Gen. Ind. Pl. Formos. 61. 1917, etc., non F.-Vill. *Myristica heterophylla* F.-Vill. is a synonym of *Knema glomerata* (Blanco) Merr. The two plants in question differ greatly and are now placed in two different genera.

Rutaceae

1. **Evodia confusa** Merr. in Philip. Jour. Sci. 20. 391, 1922.

   Evodia merrillii Kanehira & Sasaki in Kanehira, Formos. Trees rev. ed. 313, f. 267, 1936.

   Evodia roxburghiana sensu Matsum & Hay. in Jour. Coll. Sci. Tokyo 22: 70, 1906 (Enum. Pl. Formos.); Hay. Icon. Pl. Formos. 1: 118, 1911, non Benth.

Celebes and Philippines, widely distributed and common in forests at low and medium altitudes; Formosa, mostly in northern part.

Formosa: Shirin, Taihoku, *T. Tanaka & Y. Shimada 11163* (US); Kangu, *H. Keng*, Oct. 26. 1950 (US); Sinten, *H. Keng 1811* (US); Tykutan, Taihoku *Sou-Gen Lin*, Aug. 30, 1932 (NTU).

Kanehira and Sasaki cited no specimen for their species. The description and illustration are distinctive. This characteristic plant with large leaves is in all respects referable to the common Philippine species *Evodia confusa* Merr., known earlier as "*E. glabra*."

2. **Glycosmis cochinchinensis** (Lour.) Pierre ex Engl. & Prantl, Nat. Pflanzenfam. III. 4: 185, f. 106, 1895; Kanehira, Formos. Trees rev. ed. 314, f. 269, 1936.

   Toluifera cochinchinensis Lour. Fl. Cochinch. 262, 1790.

   Glycosmis citrifolia Lindley in Trans. Hort. Soc. 6: 72, 1826.

   Glycosmis pentaphylla Correa in Ann. Mus. Nat. Hist. Paris 8: 386, 1806; Matsum. & Hay. in Jour. Coll. Sci. Tokyo 22: 73, 1906; Hay. Icon. Pl. Formos. 1: 121, 1911.

   Citrus erythrocarpa Hay. Icon. Pl. Formos. 6: 13, 1916. *Syn. nov.*

   Glycosmis erythrocarpa Hay. Icon. Pl. Formos. 8: 14, 1919. *Syn. nov.*

India to Malaysia, Philippine Islands, Hainan; Formosa, common in forests at low altitudes.

Formosa: Taipei, *H. Keng 1044* (US), *K. Odashima 13607* (US), *Kei-Dai Lin*, Nov. 12, 1930 (NTU); Tamali, Taitung, *H. Keng 1376* (US); Bankinsing, *A. Henry 1487* (US), *1587* (US); Kuraru, Koshun, *E. H. Wilson 11038* (US).

This is a polymorphous tree, very variable in its features. Hayata's plant is described with smaller leaves which are usually ternate, but the characters are within the range of variation of the species.

Anacardiaceae

1. **Semecarpus gigantifolia** Vidal, Sinopsis Atlas 22, t. 36, f. A. 1883.

   Semecarpus vernicifera Hay. & Kawakami in Hay. Icon. Pl. Formos. 2: 108, 1912; Kanehira, Formos. Trees rev. ed. 367, f. 322, 1936. *Syn. nov.*

Widely distributed in the Philippines, in forests at low altitudes; Formosa, along seashore of the south and east coasts, and on Botel Tobago Island; cultivated in other places.

Formosa: Taihoku, cult., *E. H. Wilson 9910* (US), *Kei-Dai Lin*, Nov. 5. 1936 (NTU).

The Formosan plant proves to be identical with this common Philippine species, many specimens of which are available for comparison.

Aquifoliaceae

1. **Ilex asprella** (Hook. & Arn.) Champ. in Kew Jour. 4: 329, 1852; Kanehira, Formos. Trees rev. ed. 370, f. 324, 1936; S. Y. Hu in Jour. Arnold Arb. 30: 269, 1950.
   Prinos asprella Hook. & Arn. Bot. Beech. Voy. 176, pl. 36, f. 1, 2, 1833.
   Ilex arisanensis Yamamoto, Suppl. Icon. Pl. Formos. 1: 30. f. 10, 1952; Kanehira, Formos. Trees rev. ed. 370, 1936. *Syn. nov.*

Luzon to southeast China; Formosa, in the thickets from low to medium altitudes throughout the island.

Formosa: Sozan, Taihoku-shu, *T. Tanaka & Y. Shimada 11009* (US), *Y. Kudo, S. Suzuki & K. Mori*, April 21, 1929 (NTU); Mt. Kwannon, Taihoku-shu, *T. Tanaka & Y. Shimada 11094* (US); Taipei, *H. Keng 1024* (US), *T. Tanaka 76* (US); Shirin to Sozan, *E. H. Wilson 10293* (US); Musha, Nanto, *E. H. Wilson 10065* (US); South Cape, *A. Henry 1334* (US); Arisan, *Faurie 186* (cotype of *I. arisanensis* Yamamoto, photo US).

Photograph of Yamamoto's type together with his original description prove that *I. arisanensis* Yamamoto is clearly conspecific with *I. asprella*. This species has characteristically thin leaves with caudate tips and long slender pedicels. Faurie's plant, a mature fruiting specimen, has relatively larger leaves than others and also was collected at higher altitudes than most others. *Ilex arisanensis* Yamamoto was not considered in S. Y. Hu's study of the genus, and it was maintained as a distinct species by Kanehira.

Icacinaceae

1. **Gonocaryum calleryanum** (Baill.) Becc. in Malesia 1: 123, 1877.
   Phlebocalymna calleryanum Baill. in Adansonia 9: 147, 1896.
   Gonocaryum diospyrosifolium Hay. Icon. Pl. Formos. 2: 106, 1912; Kanehira, Formos. Trees rev. ed. 400 f. 359, 1936. *Syn. nov.*

Luzon, Batan Islands; Formosa, in forests along the coast, rare in Hunchuen Peninsula only.

Formosa: Koshun, Kuraru, *Y. Kudo & S. Suzuki 15889* (NTU); Kuraru, *B. Hayata & Sasaki 15621* (isotype of *G. diospyrosifolium* Hay., photo US).

Gonocaryum diospyrosifolium Hay. proves to be the same as the Philippine *G. calleryanum* (Baill.) Becc. (*G. tarlacense* Vidal). The plant is a common tree in Luzon and is also found on the Batan Islands between Luzon and Formosa. In Formosa, it is a rare plant grown only in the shore forests of Kuraru, Hunchuen Peninsula, sometimes on coral rocks.

Melastomataceae

1. **Astronia ferruginea** Elm. Leafl. Philip. Bot. 4: 1205, 1911; Merr. in Philip. Jour. Sci. 8: Bot. 342, 1913.
   Astronia formosana Kanehira, Formos. Trees 259, 1917. *Syn. nov.*
   Astronia pulchra sensu Hay. in Jour. Coll. Sci. Tokyo 30(1): 114, 1911; (Mat. Fl. Formos.), Icon. Pl. Formos. 2: 25, 1912; non Vidal.
   Astronia cumingiana sensu Kanehira, Formos. Trees rev. ed. 507. f. 469, 1939; non Vidal.

Philippine Islands, from Mindanao to Luzon; Formosa, in forests, Hunchuen Peninsula, Lutao and Lanyu (Botel Tobago).

Formosa: South Cape, *A. Henry 658* (US); Kuskus, *Y. Kudo & S. Suzuki 16066* (NTU).

The Formosan plant is neither a distinct species nor referable to either *A. pulchra* or *A. cumingiana* of the Philippines. The species is actually identical with *A. ferruginea* Elm., a more or less common species of the Philippines. The ferrugineous lepidote inflorescence and undersurface of the leaves are very distinctive and characteristic of this species.

Boraginaceae

1. **Cordia cumingiana** Vidal, Phan. Cuming. Philip. 187, 1885, Rev. Pl. Vasc. Filip. 192, 1886.

Cordia kanehirai Hay. Icon. Pl. Formos. 6: 31, 1916; Hou in Taiwania 1: 207, 1950. *Syn. nov.*

Luzon; Formosa, in the thickets in southern part only, scarce.

Formosa: Koshun, *E. Matuda 1553* (NTU); Kuraru, Koshun, *R. Kanehira 7* (isotype of *C. kanehirai*, photo US).

Hayata originally placed this plant as a close ally of *C. cumingiana*. In comparing specimens from the two regions, it is found that the Formosan plant cannot be differentiated from the Luzon plant and must be considered as conspecific.

2. **Cynoglossum lanceolatum** Forsk, Fl. Aegypt. Arab. 41, 1775; Hou in Taiwania 1: 217, 1950.

Cynoglossum alpestre Ohwi in Acta Phytotax. Geobot. 2: 150, 1933; Hou in Taiwania 1: 218, 1950. *Syn nov.*

India, Southern China to the Philippines; Formosa, mountain regions.

Formosa: No precise locality, *A. Henry 1015* (US); Arisan, *T. Tanaka 520* (US); *S. Suzuki*, July 17, 1937 (NTU).

No isotypes of Ohwi's species are available, but, among the cited specimens, *Suzuki s. n.* most closely approaches the original description of *C. alpestre* in having longer, denser hairs and smaller, thicker leaves than other specimens of *C. lanceolatum*. These characters are, however, evidently due to higher elevations, whereas there are no structural differences between plants of higher and lower altitudes. *Cynoglossum alpestre* Ohwi can at most be considered an alpine form of the species *C. lanceolatum*, but, in view of the wide distribution and variable nature of the species, it seems not desirable to recognize it taxonomically.

3. **Ehretia navesii** Vidal, Rev. Pl. Vasc. Filip. 194, 1886.

Ehretia resinosa Hance in Jour. Bot. 299, 1880; Hou in Taiwania 1: 203, 1950. *Syn. nov.*

Ehretia formosana Hemsl. in Jour. Linn. Soc. Bot. 26: 144, 1896. *Syn. nov.*

Philippine Islands; Formosa, in southern part, along the seashore.

Formosa: Takao, *A. Henry s. n.* (US), *K. Moritani 2308* (NTU); Kuraru, *E. H. Wilson 10967* (US).

The Formosan plant proves to be the same as the Philippine *E. navesii* Vidal, a characteristic plant readily distinguished by the long-linear and persistent calyx-lobes which enclose the globose fruit at maturity.

Verbenaceae

1. **Premna nauseosa** Blanco, Fl. Filip. 489, 1837.

Premna integrifolia Blanco, Fl. Filip. ed. 2. 342, 1845; Matsum. & Hay. in Jour. Coll. Sci. Tokyo 22: 299, 1906 (Enum. Pl. Formos.); non Linn.

Premna obtusifolia sensu Sasaki, List. Pl. Formos. 353, 1938; Mori in Masamune, Short Fl. Formos. 181, 1936; non R. Br.

Premna odorata sensu Yamamoto in Jour. Soc. Trop. Agr. 6: 554, 1934, p. p.; Kanehira, Formos. Trees rev. ed. 654, 1936, p. p.; non Blanco.

Philippine Islands; Formosa, in southern part only.

Formosa: No precise locality, *A. Henry 613, 791* (US).

This is an exceedingly common species in the Philippine Islands, generally known as "*P. integrifolia*." This species was confused by many authors, including Kanehira, with *P. odorata*, another Philippine species that occurs also in southern Formosa. In *P. odorata* the leaves are densely tomentose beneath. In *P. nauseosa* the leaves are more or less glabrous beneath.

2. **Premna odorata** Blanco, Fl. Filip. 488. 1837; Yamamoto in Jour. Soc. Trop. Agr. 6: 554, 1934, p. p.; Kanehira, Formos. Trees rev. ed. 654, f. 610, 1936, p. p.

Premna vestita Schauer in DC. Prodr. 11: 631, 1847; Henry in Trans. As. Sci. Jap. 24. Suppl.: 70, 1896.

Widely distributed in Luzon; Formosa, in forests near seashore in northern and southern parts.

SUMMARY

The floras of Formosa and the Philippines are distinctive in their general nature. The former is related especially to the Chinese mainland and the latter to Malaysia. Their close geographic proximity, however, has allowed certain floristic interchanges in relatively recent times. An earlier movement was the southward migration of temperate elements from Formosa to the Philippines. These are mostly montane and alpine elements and, in the Philippines, largely confined to the mountains of northern Luzon. These elements are now of wide disjunct distribution and are related to the alpine floras of western China and the Himalayas. A more recent movement is the northward expansion of tropical elements from the Philippines to Formosa. These are usually lowland plants and are found in Formosa limited mostly to the southern extreme of the island and the adjacent small islands Lanyu and Lutao. Floristic notes on certain species common to the Philippine and Formosan floras but considered by former authors as distinct are given.

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Observations on the Subgenus *Phalangomyia* of the Genus *Culex* in Ecuador with Description of a New Species (Diptera: Culicidae)

ROBERTO LEVI-CASTILLO[1]

THE SUBGENUS *Phalangomyia* has rather generally been considered as a synonym of the subgenus *Culex* although, especially in the species found in Ecuador and described herein, it has characters which differentiate it very clearly. The terminalia are very characteristic. The strongly chitinized structure of the clasper and the presence of strong hairs on its outer surface constitute a great difference from the condition found in members of the subgenus *Culex*. *Phalangomyia* seems to represent one of the oldest branches of the genus *Culex*, as indicated by its adaptation to a high-altitude environment.

All the members of this subgenus are found only in the Andean countries of South America. They are large mosquitoes with very well-developed bodies and strong, long legs. They are adapted for high-altitude flying and for low oxygen consumption and, therefore, are always found at altitudes of more than 2,000 meters above sea level, where no other mosquitoes and few other insects of any sort can live. One of the two species considered here was found at an altitude of 2,900 meters near the city of Quito and the other near the town of Cuenca at an altitude of 2,500 meters. In the Andean region of Ecuador the median temperature is ordinarily between 14.5° and 20°C. (58°—68°F.), and wind velocities of 5 to 25 miles per hour prevail. Thus, in order to live, mosquitoes must be adapted to this environment.

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The most interesting characteristic of these mosquitoes is the fact that larvae, pupae, or adults die very shortly if they are taken to sea level, apparently because their metabolism has been adapted to the oxygen shortage of the high altitudes of the Andes. Thus the author was unable to breed larvae of *Phalangomyia* at sea level, even when water from the breeding places, with all the algae present, was brought to the laboratory. Apparently, then, compression is a main factor in killing the larvae, although they sometimes survive 10 to 12 hours of being at sea level. Also temperature changes will kill the larvae, and at sea level both the temperature and humidity are higher than those at over 2,000 meters above sea level. However, even placing the larvae brought to sea level in refrigerators held at the same temperatures as the highlands does not prevent their dying in a few hours. This proves that the subgenus *Phalangomyia* is only adapted to live at high altitudes, in the Andean region of Ecuador. The problem of the effects of oxygen, basal metabolism, and environment on highland mosquitoes has not been studied sufficiently, and it is one of the research projects of the Ecuadorian Center for Entomological Research.

Two species of *Phalangomyia* have been taken in the highlands of Ecuador, one previously known and one new to science. They are both described here.

Culex (Phalangomyia) archegus Dyar, 1929

LARVA (Fig. 1*a*, *b*): *Head* rounded, wider than long. *Antennae* long, tapering, with a sub-

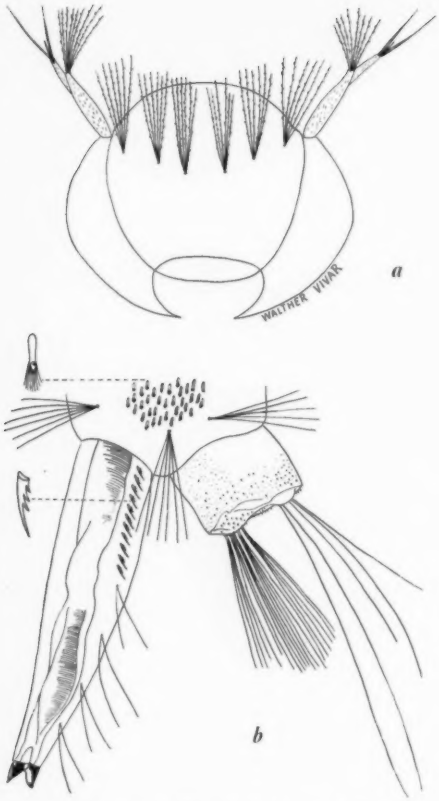

FIG. 1. Larval structures of *C.* (*Ph.*) *archegus*. *a*, Head; *b*, cauda.

apical hair tuft, spiculate body, and 2 pairs of long apical hairs. *Preantennal hairs* 6 to 8, finely spinulate, longer than the antennae. *Interior dorsal hairs* 4 to 6, finely spinulate. *Exterior dorsal hairs* 3 to 4, spinulate.

Comb of the eighth abdominal segment (Fig. 1*b*) formed by a patch of elongate teeth with apex hairy. *Air tube* long, 4.5 times as long as wide. *Pecten* of 13 to 15 triangular scales, sharp and with 3 to 5 teeth each. Tuft of the pecten double and long, other tufts double and long, located at different places along the air tube. *Anal segment* longer than wide, finely spinulate on most of its surface. *Lateral hair tuft* double and large. *Dorsal brush* formed by 3 long, strong elements. *Ventral brush* formed by 8 hairs, 4 elements each, very well developed and long.

PUPA (Fig. 2*a*, *b*) (Chaetotaxy according to Knight and Chamberlain, 1948): *Segment I*, hair 10 well developed and long, hair 2 with strong base, very ramified; *Segment II*, hair 8 developed, long, hair 2 long and thin; *Segment III*, hairs 2 and 5 long and ramified, hair 7 long; *Segment IV*, hairs 2 and 5 ramified and long, hairs 4, 6, 7 long; *Segment V*, hair 2 ramified and long, hair 5 very long and diramified; *Segment VI*, hair 2 diramified and very long, hair 5 ramified and long, hair 7 long and simple; *Segment VII*, hair 2 medium

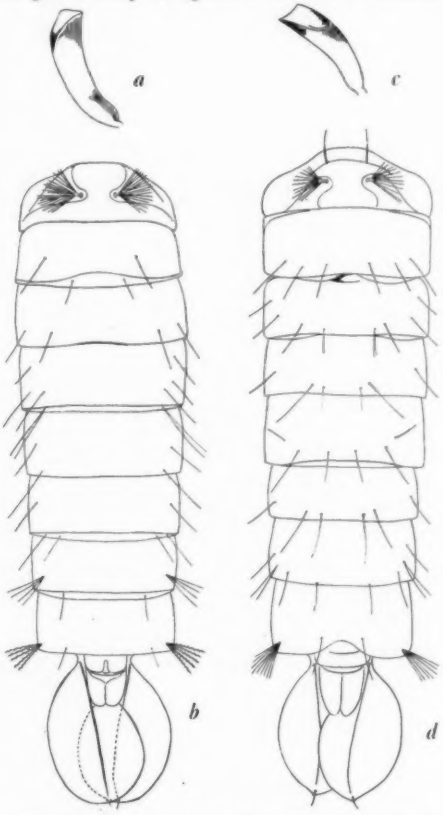

FIG. 2. Pupal structures of *C.* (*Ph.*) *archegus* Dyar and *C.* (*Ph.*) *quitensis* n.sp. *a*, Trumpet of *C. archegus; b*, dorsal aspect of abdomen of *C. archegus; c*, trumpet of *C. quitensis; d*, dorsal aspect of abdomen of *C. quitensis*.

and diramified, hair 6 long and simple, hair 5 medium and diramified, hair 8 ramified and very well developed; *Segment VIII*, hair 5 medium and simple, hair 8 multiramified, very well developed and spiculated. *Pupal trumpets* longer than wide, with a triangular opening, rounded at the angular borders, tapering and very sinuous. *Pupal paddles* rounded with strong medium rib, apical hairs small.

ADULT (both male and female): Proboscis medium, slightly enlarged near the tip, olive green. Palpi thin and long in the males, short and lobulous in the females, with many setae, olive green and black. Vertex with dark integument revetted with plumous white scales, which form an overlapping tuft toward the clypeus, and bordering the eyes. Occiput dark with plumous scales as on the vertex. Prothoracic lobes revetted with golden scales and dark hairs. Mesonotum with 3 strips of small, compact brown scales forming circular spots at the wing base, the disc revetted with small golden hairs, with clear spaces among the compact scales. Scutellum trilobate with the median lobe larger than the others, with golden scales as on the mesonotum, with long dark hairs on all the lobes. Postnotum bare of scales, light brown. Abdomen olive brown, segments with basal white bands that become larger, forming wide white bands that cover lateral portion of abdomen, white scales covering nearly all of preapical segment and apical segment except for small black spot. Venter with central dark portion toward which lateral white bands converge, forming lateroventral white spots. Legs long, second and third pairs successively larger. All legs black, with basal and apical white spots on femora and tibiae. Segments of tarsi with small white spots at base and tip. Wings revetted with small dark scales.

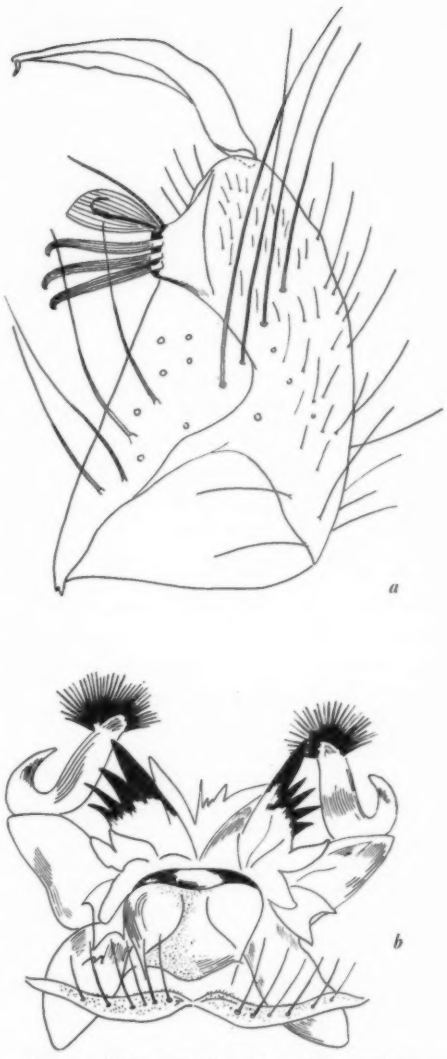

FIG. 3. Male terminalia of *C.* (*Ph.*) *archegus*. *a*, Coxite and clasper; *b*, mesosomal plate, tenth sternites, and ninth tergites.

Male Terminalia: Coxite (Fig. 3*a*) triangular, tapering, external surface bearing many long and strong setae, basal portion with micropili and sinuosities. Subterminal lobe prominent, short, with 3 sinuous rods, median one slightly curved apically, all 3 arising from tubercular bases, lobe also bearing very thin hair-like filament slightly curved at tip and shorter than rods. In addition, subterminal lobe with very large ovate leaf and long rod-like seta, almost as stout as rods. Clasper curved, broadened centrally, tapered distally,

with triangular spine nearly terminal. Mesosomal plate (Fig. 3*b*) with upper limb short, lower recurved, thumb-shaped, with several curved teeth between the lower and a very large tooth which arises from base and which tapers sharply distally and projects beyond plate. Tenth sternites with tips tufted with spines, with wide, very long curved arm from base. Ninth tergites forming elongate lobes with 6 to 8 thin long hairs, lobes very hairy and well sclerotized.

Culex* (*Phalangomyia*) *quitensis n.sp.

LARVA (Fig. 4*a*, *b*): *Head* round. *Antennae* long, tapering, with subapical hair tuft, spiculate body, 1 pair of long tapering hairs, 1 pair of short tapering hairs. *Preantennal hairs* 4 to 6 finely spinulate hairs. *Interior dorsal hairs* a bunch of 4 to 6 finely spinulate hairs. *Exterior dorsal hairs* 4 to 6 finely spinulate hairs.

Comb of eighth abdominal segment (Fig. 4*b*) formed by patch of oval teeth with apex hairy. *Air tube* long, 3.5 times as long as wide. *Pecten* of 14 to 16 conical scales with 4 to 6 teeth each. Tuft of pecten simple or double, finely spinulate, other tufts formed of 1 to 3 spinulated hairs located at different places along air tube. *Anal segment* wider than long, spinulate, with small and medium spinules on most of surface. *Lateral hair tuft* double, long and spinulate. *Dorsal brush* formed of 3 long, strong, spinulate hairs. *Ventral brush* formed of 6 to 8 hair tufts of 4 elements each, very well developed and long.

PUPA (Fig. 2*c*, *d*) (Chaetotaxy according to Knight and Chamberlain, 1948): *Segment I*, hair 10 well developed and long, hair 2 with strong base, very ramified; *Segment II*, hairs 2, 4, 8 long and simple; *Segment III*, hairs 2, 5, 8 long and simple; *Segment IV*, hairs 2, 8 long and simple; *Segment V*, hairs 2, 5, 6 long and simple; *Segment VI*, hairs 2, 5, 7 long and simple; *Segment VII*, hairs 2, 5, 7 long and simple, hair 8 long and diramified; *Segment VIII*, hair 5 long and simple, 8 long and multiramified. *Pupal trumpets* longer than wide, with wide pyramidal opening, rounded on one angle, tapering and very sinuous. *Pupal paddles* rounded, with strong median rib, apical hairs medium.

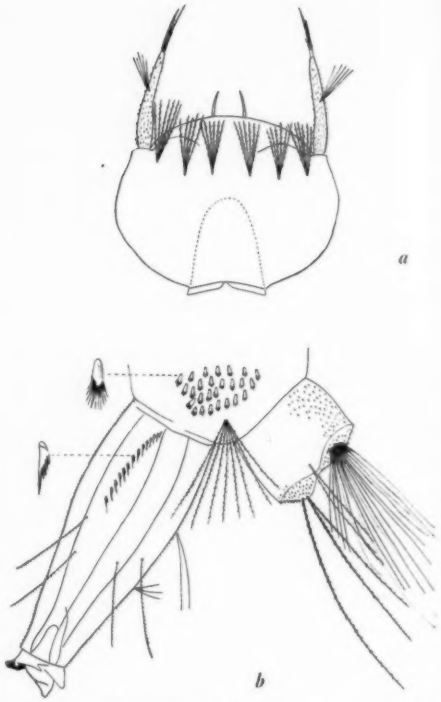

FIG. 4. Larval structures of *C.* (*Ph.*) *quitensis*. *a*, Head; *b*, cauda.

ADULT (both male and female): Proboscis black with white tip. Palpi black with white tips, small and hairy in female, long and thin in males. Vertex with white, truncate, triangular scales, dark triangular scales, and black setae, forming tufts that overhang clypeus. Occiput with white and black triangular scales. Borders of eyes with dark setae. Prothoracic lobes with integument dark brown, with long and strong hairs. Mesonotum with two bare lines, forming a lyre-like structure, with white scales, very compressed, forming tufts at bases of wings. Disc covered with dark-brown compressed scales and dark setae, posteriorly revetted with white scales and dark long setae.

Scutellum trilobed, revetted with white scales and dark hairs. Postnotum bare with integument dark brown. Abdomen covered dorsally by brown scales and with basal spots of silvery white scales in each segment which become lateral bands. Venter with dark-brown scales in straight line up to tip, bands of white scales diverging from this line to form lateral spots of white scales. Legs very long, posterior pair longest. Pleurae and coxae revetted with white scales forming tufts and spots. Legs dark brown with femora and tibiae white ventrally and on dorsum basally and apically, segments of tarsi dark brown with white spots on knees. Wings large with small dark scales.

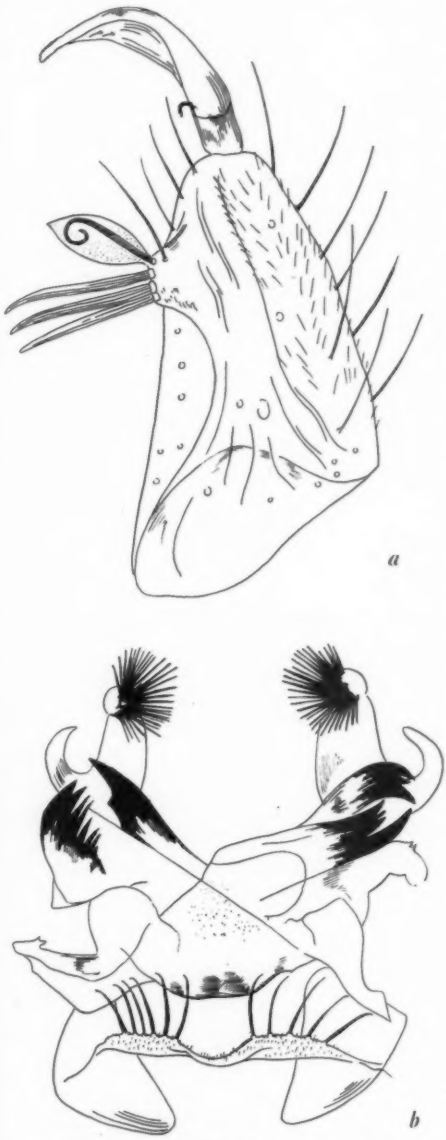

FIG. 5. Male terminalia of *C.* (*Ph.*) *quitensis*. *a*, Coxite and clasper; *b*, mesosomal plate, tenth sternites, and ninth tergites.

Male Terminalia: Coxite (Fig. 5*a*) triangular, tapering, external surface bearing many short, strong setae, and very small hairs. Subterminal lobe prominent, short, with 4 rods, one smaller and with tip curved like question mark, other 3 sinuous, slightly curved subapically, lobe also bearing medium-sized ovate leaf and long hair-like seta, all arising from tubercular bases. Clasper curved, very broad basally, tapering apically, with two small subapical setae and very small terminal spine. Mesosomal plate (Fig. 5*b*) with upper limb broad, with several spine-like teeth, very large formation of teeth from base curving sharply outward and projecting as a point beyond plate. Tenth sternites with tips tufted with spines, with wide, curved, very long arm from base. Ninth tergites forming elongate lobes with 6 to 10 long, strong, terminally curved hairs, lobes very hairy and well sclerotized.

TYPES: 2 males, 1 female, and their larval and pupal pelts in the collection of the Ecuadorian Center for Entomological Research.

TYPE LOCALITY: Quito, Ecuador (South America).

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A Systematic Catalogue of Australian Braconidae

ARTHUR W. PARROTT[1]

INTRODUCTION

IT HAS BEEN 60 YEARS since a list of the Braconidae of Australia was published, excepting the world lists compiled by Dalla Torre (1898) and Szépligeti (1904). In 1891, Froggatt published his "Catalogue of Described Hymenoptera of Australia" in which he lists eight species of braconids. Nine years later Dalla Torre's world catalogue appeared in which he records 28 species from Australia and Tasmania. As far as the Australian fauna is concerned, there are errors and ommissions which diminish the value of this great work, and in the present catalogue it is referred to only when the nomenclature of a species is affected. For example, Dalla Torre does not mention Guérin's genus *Trachypectus* and records *Bracon bicolor* Brullé from Africa and *Myosoma mutator* Fabr. from America. The next list was published in Szépligeti's "Genera Insectorum," Parts I and II, which appeared in 1904. While Szépligeti was preparing this work, he was actively engaged in a study of the Australian fauna and thus added greatly to our knowledge of this group. He lists 37 species from Australia and Tasmania. The present list records 224 species from Australia and Tasmania.

Unquestionably the taxonomy of the Braconidae is rather confused. Further studies will undoubtedly result in much more synonymy and in the resurrection of some species and genera now suppressed. The great diversity of species occurring in Australia and neighbouring regions necessitates an enormous amount of work before a proper arrangement of species and their synonymy can be formulated. The arrangement of the genera and higher groups, in the present catalogue, is substantially that used by Muesebeck (1951: 90–184).

For the majority of species listed, I have had access to the original works, but those that were not available to me I have checked with other authors and in the Zoological Record. In compiling the synonymy of the older species, especially those of Fabricius and Brullé, and of the several more or less cosmopolitan species, a complete bibliography is not given, but invariably the original reference, together with all subsequent references where nomenclature is affected, is included. All references are included when a fuller description or figures are given, or when reference is made to the host or distribution of the species concerned. At the end of the catalogue is a list of beneficial species introduced and liberated for purposes of biological control. Established aliens, accidentally introduced species, and those occurring naturally outside the Australian area are given in the body of the catalogue with an indication of their distribution outside Australia. A host index is included as well as a general index, listing all subfamily, generic, specific, and subspecific names included in the catalogue.

Every endeavour has been made to make this catalogue as complete as possible; nevertheless, there may be ommissions, and perpetuations of errors occurring in early records, and subsequent authors' corrections may have been overlooked, but it is hoped that such errors have been reduced to a minimum.

[1] Entomologist, Cawthron Institute, Nelson, New Zealand. Manuscript received March 1, 1952.

HISTORICAL

The history of Australian braconid systematics may be divided conveniently into four major periods of activity, namely, 1777 to 1890, 1891 to 1913, 1914 to 1927, and 1928 to 1951.

First Period 1777–1890.

Australian braconid systematics commenced with the publication of the description of new species by Fabricius in 1777, and was ably carried on by Brullé in 1846. Other workers who described Australian species during this period were Erichson, Guérin-Méneville, and Holmgren. During this period, 15 species were described from Australia and Tasmania. Fabricius worked on the collections made by Banks and Solander, naturalists on the "Endeavour" during Cook's voyages. These early Australian species were collected by Banks and Solander on the return journey of the "Endeavour" to England after observing the transit of Venus at Tahiti. The "Endeavour" was in Australian waters from April to August, 1770, and, according to Musgrave (1930: 190), the insects were mostly captured around Botany Bay and the east coast of Australia. From this material, four species of Braconidae were described, and the types are in the Banksian Collection in the British Museum. It was not until 1824 that the next braconids to be described from Australia were obtained during the voyage of the "Coquille", commanded by L. I. Duperrey. Lessen and Garnot were the naturalists, and the insects were later described by Guérin-Méneville. A footnote (a) by Musgrave (1930: 194) states "In Duperrey's 'Voyage autour du Monde . . . sur . . . La Coquille, pendant les Anneés 1822–1825.' The plates, with the scientific names of the insects appeared between 1827–1832, but the text did not appear until 1838."

Erichson described a species from Tasmania in 1841. Five years later, Brullé (1846) described eight species from Australia and Tasmania in his great work "Histoire Naturelle des Insects." A specimen collected at Sydney, New South Wales, was described by the well-known European hymenopterist Holmgren in 1868. No further species were described during this period. Thus, 15 species of braconids were known from Australia and Tasmania to 1890.

Second Period 1891–1913

This period may conveniently begin with the publication of Froggatt's "Catalogue of Described Hymenoptera of Australia," in which he lists eight species of braconids from Australia (actually 15 species were known at this time). During the 22 years covered by this period, Ashmead, Froggatt, Cameron, Szépligeti, Bingham, and Kokujew contributed to the knowledge of the Australian members of this family. Szépligeti, between the years 1901 and 1908, played the most prominent part.

A German expedition collected a number of insects in southwest Australia in 1905 which later were described by specialists in "Die Fauna Südwest-Australiens. 1907–1910," in which Szépligeti (1908) described the Braconidae.

Third Period 1914–1927

The works of R. E. Turner (1917–27) dominate this period, although those of Froggatt, Fullaway, and Baker must be mentioned. The period closes with the publication in 1926 of Baker's work on the Australian and Philippine Cheloninae.

An expedition, headed by Dr. E. Mjoberg, traveled into Queensland and northwest Australia. The Braconidae were described by Roman (1915).

Fourth Period 1928–1951

During this period a great amount of important revisional work was undertaken, principally by Wilkinson, on the Microgasterinae; this work was ably continued by Nixon. These authors dealt with the faunas of large regions and placed the systematics of Australian Braconidae on a sound basis in indicating their relationship with other faunas.

The works of Wilkinson and Nixon in England and Muesebeck in the United States have undoubtedly contributed toward a sounder knowledge of braconid systematics generally, and their work forms a basis for a clearer interpretation of the Australian forms in particular.

Other workers have contributed to the knowledge of the Australian braconid fauna, but those mentioned have made the principal contributions.

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To Dr. Leonard Tuthill, Professor of Entomology, University of Hawaii, Honolulu, I want to convey my very sincere thanks for suggestions on the layout of this catalogue; without his kindly co-operation this work would not have been completed.

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ABBREVIATIONS OF MUSEUMS

The following abbreviations are used in giving the location of types of Australian Braconidae.

B.M.	British Museum of Natural History, London
H.D.O.M.	Hope Department, Oxford Museum, Oxford.
H.E.S.	Hawaii Entomological Society Collections, Honolulu.
N.C.A.C.	National Collections of Australia, Canberra.
N.H.M.	National Hungarian Museum, Budapest.
N.H.M.S.	Natural History Museum, Sweden.
N.H.M.V.	Natural History Museum, Vienna.
N.K.	Location not known.
S.C.M.G.	Saussure Collection, in Museum, Geneva.
U.S.N.M.	United States National Museum, Washington.

Order HYMENOPTERA

Suborder APOCRITA (= CLISTOGASTRA)
Superfamily ICHNEUMONOIDEA

Family BRACONIDAE

Subfamily *APHIDIINAE*

All members of this subfamily are internal parasites of aphids.

Genus DIAERETUS Foerster, 1862

rapae (Curtis)

Curtis [*Aphidius*] (1855, 2: 194) ♀ descr.
Ashmead [*Lipolexis*] (1900: 353) Austr. record.
Froggatt [*Lepolexis*] (1907: 87) noted.
Cameron [*Lipolexis*] (1912: 197) Austr. record.
Smith (1944: 101) syn., descr., fig.
Loc: Victoria; New South Wales.
Hosts: *Rhopalosiphum pseudobrassicae* (Davis).
Mysus persicae (Sulz).
Brevicoryne brassicae (Linn.).
Type: N.K.
Note: This European species is now well established in at least the southern

states of Australia and also in New Zealand.

Genus **Ephedrus** Haliday, 1833

persicae Froggatt
Froggatt (1904: 611) ♀ descr.
Froggatt (1907: 86) note, fig.
Froggatt (1910: 342) host, fig.
Loc: New South Wales.
Host: Peach aphis.
Type: N.K.
Note: This species is probably a European species that has become established in Australia.

Subfamily *EUPHORINAE*
(= *Meteorinae*)

The members of this subfamily attack a wide range of hosts, but all species are internal parasites.

Genus **Aridelus** Marshall, 1887
(= *Helorimorpha* Schmied., 1907)

exiles (Turner)
Turner [*Helorimorpha*] (1927: 558) ♂ descr.
Loc: Mackay, Queensland.
Type: B.M.

Genus **Meteorus** Haliday, 1835
(= *Protelus* Foerster, 1862)

Most species of this genus are parasitic on lepidopterous larvae, but some are known to parasitise Coleoptera.

antipodalis Ashmead
Ashmead (1900: 353) ♀ descr.
Loc.: New South Wales.
Type: U.S.N.M. (No. 4908).

bicolor Szépligeti
Szépligeti (1905: 53) ♀ descr.
Loc: New South Wales.
Type: N.H.M.

dumbletoni Muesebeck
Muesebeck (1939: 172) ♂ ♀ descr.
Dumbleton (1940: 325a) host, biol., distr.
Loc: Hobart, Tasmania.
Host: *Tortrix postvittana* Walk.
Type: U.S.N.M. (No. 53341).

lutens (Cameron)
Cameron [*Protelus*] (1911: 341) ♀ descr.
Loc: Sydney, New South Wales.
Host: *Teara* sp. [Notodontid.].
Type: B.M.

Genus **Perilitus** Nees, 1818
(= *Dinocampus* Foerster, 1862)

The species of this genus are internal parasites of adult Coleoptera.

coccinellae (Schrank)
Schrank [*Ichneumon*] (1802, 2: 310) ♀ descr.
Nees [*Bracon terminatus*] (1811: 26) ♀ descr.
Nees [*Perilitus terminatus*] (1834: 30) ♂ ♀ descr.
Dalla Torre (1898: 122) listed.
Szépligeti [*Dinocampus terminatus*] (1904: 175) listed.
Timberlake [*D. terminatus*] (1918: 401) Austr. record.
Cushman [*Dinocampus*] (1922: 242) syn.
Muesebeck (1951: 101) syn., listed.
Loc: Queensland. This species is nearly cosmopolitan.
Hosts: *Hippodamia convergens* Guer.
H. 5-signata (Kby.).
Coccinella californica Mann.
Coleomegilla maculata (Deg.).
Cycloneda sanguinea (L.).
C. trifasciata juliana Muls.
Type: N.K.

Subfamily *MACROCENTRINAE*

Internal parasites of lepidopterous larvae. The gregarious forms seem to be polyembryonic.

Genus **Macrocentrus** Curtis, 1833
(= *Amicroplus* Foerster, 1862)
(= *Fhogra* Cameron, 1901*a*)

ancylivorus Rohwer
Rohwer (1923: 56) ♀ descr., N. America.
Loc: Liberated in Goulburn Valley, Victoria.
Host: *Grapholitha molesta*, Busck. [Olethreutid.].
Type: U.S.N.M.

rubromaculatus (Cameron)
Cameron [*Fhogra*] (1901*b:* 104) descr., New Zealand.
Wilkinson [*Amicroplus tasmanicus*] (1928*b:* 265) descr. [New synomymy].
Loc: New Zealand; Longford, Tasmania.
Host: *Argotis* sp. (or allied Noctuid).
Type: B.M.

Subfamily *HELCONINAE*

The species of this subfamily, with few exceptions, appear to be parasitic on wood-boring coleopterous larvae.

Tribe HELCONINI

Genus AUSTROHELCON Turner, 1918

australiansis (Kokujew)
Kokujew [*Helcon*] (1901: 15) ♂ descr.
Szépligeti [*Aspidocolpus*] (1904: 152) listed.
Turner (1918*d:* 165) nomencl., note.
Loc: Tasmania (Kokujew); New South Wales (Turner).
Type: N.K.

erythrocephalus Turner
Turner (1918*d:* 167) ♂ descr.
Loc: Victoria.
Type: B.M.

indultor (Erichson)
Erichson [*Helcon*] (1842: 258) ♂ descr.
Dalla Torre [*Helcon*] (1898: 84) listed.
Szépligeti [*Helcon*] (1904: 151) listed.
Turner (1918*d:* 165) nomencl., note.
Loc: Tasmania.
Type: N.K.

inornatus (Kokujew)
Kokujew [*Helcon*] (1902: 15) ♂ descr.
Szépligeti [*Aspidocolpus*] (1904: 152) listed.
Turner (1918*d:* 165) nomencl., note.
Loc: Australia.
Type: N.K.

meridionalis Turner
Turner (1918*d:* 167) descr.
Loc: Victoria.
Type: B.M.

Genus CALOHELCON Turner, 1918

obscuripennis Turner
Turner (1918*d:* 165) descr.
Loc: Victoria.
Type: B.M.

Genus HELCON Nees, 1814 (1812)
(= *Gymnoscelus* Foerster, 1862)

rufithorax Turner
Turner [*Gymnoscelus*] (1918*d:* 170) descr.
Loc: Victoria.
Type: B.M.

rufoniges Turner
Turner [*Gymnoscelus*] (1918*d:* 169) descr.
Loc: Tasmania.
Type: B.M.

Genus PARAHELCON Kokujew, 1901

konowi Kokujew
Kokujew (1901: 15) ♀ descr., n. gen.
Cameron [*Opius euthyrrhini*] (1912: 197) ♀ descr., host.
Loc: New South Wales, Australia.
Host: *Euthyrrhinus meditabundas* Fabr. (palm weevil).
Type: N.K.; Cameron's type, B.M.

Genus TRICHIOHELCON Turner, 1818

phoracanthae (Froggatt)
Froggatt [*Iphiaulax*] (1916: 565) ♀ descr., fig.
Froggatt [*Iphiaulax*] (1923: 42) descr., fig., host.
Turner (1918*d:* 168) nomencl., note.
Loc: S. E. Australia; Tasmania.
Host: *Trogodendron fasciculatum* Schreiber (Clerid.).

Genus TRACHYPETUS Guérin, 1838

The true position of this genus is doubtful; it was placed in the subfamily Cheloninae by Szépligeti (1904: 99), but Brues transferred it to the Helconinae.

clavatus Guérin
Guérin (1830: 201) ♂ descr., fig.
Schulz (1911: 85) noted.
Brues (1920: 59) nomencl.
Loc: New South Wales, Queensland.
Type: N.K.

Tribe DIOSPILINI

Genus **Diospilus** Haliday, 1833

ruficeps Szépligeti
Szépligeti (1905: 14) descr.
Loc: New South Wales.
Type: N.H.M.

Genus **Westwoodiella** Szépligeti, 1904

bicolor Szépligeti
Szépligeti (1904: 155) ♀ descr.
Loc: Sydney, New South Wales.

ruficeps (Brullé)
Brullé [*Westwoodia*] (1846: 127) descr., fig.
Loc: Tasmania.
Type: N.K.

Tribe ZELINI

This tribe has previously been placed in the Macrocentrinae, but I have followed Muesebeck (1951: 111) in placing it in the *Helconinae*.

Genus **Zele** Curtis, 1832

australiensis Nixon
Nixon (1938: 419) ♀ descr.
Loc: Mackay, Queensland.
Type: B.M.

Subfamily *BLACINAE*

Genus **Orgiloneura** Ashmead, 1900

antipoda Ashmead
Ashmead (1900: 355) ♀ descr.
Loc: Australia.
Type: U.S.N.M. (No. 4910).

Genus **Orgilus** Haliday, 1833
(= *Ischius* Wesmael, 1837)

leucogaster (Holmgren)
Holmgren [*Ischius*] (1868: 429) ♂ descr.
Froggatt [*Ischius*] (1890: 713) listed.
Dalla Torre (1898: 128) listed.
Szépligeti (1904: 120) listed.
Loc: Sydney, New South Wales.
Type: N.H.M.S.

Subfamily *AGATHIDINAE*

As far as is known, all species of this subfamily are internal parasites of lepidopterous larvae.

Genus **Agathiella** Szépligeti, 1902

festinata Turner
Turner (1918*a*: 111) ♀ descr., key.
Loc: South Australia.
Type: B.M.

latibalteata (Cameron)
Cameron [*Agathis*] (1906: 26) ♂ descr.
Turner (1918*a*: 110) note., nomencl., key.
Loc: Australia.
Type: B.M.

maligna Turner
Turner (1918*a*: 112) ♀ descr., key.
Loc: S.W. Australia.
Type: B.M.

meridionalis Turner
Turner (1918*a*: 110) ♀ descr., key.
Dumbleton (1940: 325a) host.
Loc: Mt. Wellington, Tasmania.
Host: *Tortrix postvittana* Walk. (Tortricid.).
Type: B.M.

minima Turner
Turner (1918*a*: 113) ♀ descr., key.
Loc: Kuranda, Queensland.
Type: B.M.
Note: "It is possible that Ashmead's genus *Orgiloneura* may be founded on a species of this genus, with somewhat reduced neuration, but his description is too short for any conclusions to be drawn." (Turner 1918*a*: 113).

ruficeps Szépligeti
Szépligeti (1905: 52) ♂ descr.
Turner (1918*a*: 110) note, key.
Loc: Sydney, New South Wales.
Type: N.H.M.

rugosa Turner
Turner (1918*a*: 112) ♂ ♀ descr., key.
Loc: Tasmania.
Type: B.M.

tenuissima Turner
Turner (1918*a*: 111) ♀ descr., key.
Loc: Victoria.
Type: B.M.
Note: Possibly a female of *A. ruficeps* Szépl. (Turner).

tricolor Szépligeti
Szépligeti (1905: 52) ♀ descr.
Turner (1918*a:* 110) note, key.
Loc: Sydney, New South Wales.
Type: N.H.M.
unimaculata Turner
Turner (1918*a:* 111) ♂ descr., key.
Loc: Kuranda, Queensland; Sydney, New South Wales.

Genus AGATHIS Latreille, 1804

(= *Bassus* Fabr., 1804)
(= *Microdus* Nees, 1814)

The two species described by Brullé in 1849 are listed under this genus, but it is doubtful whether they are typical *Agathis*. In 1918 Turner (p. 110) stated "as far as I am aware typical *Agathis* does not occur in Australia." Brullé's species may probably belong to Agathiella Szépl. Muesebeck (1951: 117) synonymises *Microdus* Nees, 1814 (1812) with *Agathis* Latr., 1804, and the four species described by Turner under *Microdus* are listed here under Latreille's genus.
bicolor Brullé
Brullé (1846:483) descr.
Froggatt (1890: 710) listed.
Loc: Australia.
Type: N.K.
dimidiata Brullé
Brullé (1846: 487) descr.
Froggatt (1890: 710) listed.
Loc: Tasmania.
Type: N.K.
martialis (Turner)
Turner [*Microdus*] (1918*a:* 108) ♂ ♀ descr., key.
Loc: Kuranda, Queensland.
Type: B.M.
pedunculatus Szépligeti
Szépligeti (1905: 51) ♀ descr.
Turner (1918*a:* 106) note.
Loc: Sydney, New South Wales.
Type: N.H.M.
rufithorax (Turner)
Turner [*Microdus*] (1918*a:* 106) ♀ descr., key.
Loc: Kalamunda, Yallingup, S.W. Australia.
Type: B.M.
rufobrunneus (Turner)
Turner [*Microdus*] (1918*a:* 106) ♀ descr., key.
Loc: Townsville, Queensland.
Type: B.M.
xanthopsis (Turner)
Turner [*Microdus*] (1918*a:* 107) ♂ ♀ descr., key.
Loc: Yallingup, S.W. Australia.
Type: B.M.

Genus BIROIA Szépligeti, 1900

solitaria Turner
Turner (1918*c:* 229) ♂ ♀ descr.
Loc: Mackay, Queensland.
Type: B.M.

Genus BRAUNSIA Kriechbaumer, 1894

bicolor Brullé
Brullé (1846: 483) ♀ descr.
Dalla Torre [*Agathis*] (1898: 138) listed.
Loc: Australia.
Type: N.K.
diversipennis Turner
Turner (1918*c:* 224) ♂ descr.
Loc: Mackay, Queensland.
Type: B.M.

Genus CREMNOPS Foerster, 1862

(= *Bracon* Auct. not of Fabricius. See Opinion 162 of the Internatl. Comm. on Zool. Nomencl. 1945.)
commutator Turner
Turner (1918*c:* 223) ♀ descr., key.
Loc: Mackay, Queensland (Type), Kuranda, Townsville, Queensland; Port Darwin, Northern Territory.
Type: B.M.
dissimilis Turner
Turner (1918*c:* 222) ♂ ♀ descr., key.
Loc: Mackay, Queensland.
Type: B.M.
marginipennis Turner
Turner (1918*c:* 222) ♂ ♀ descr., key.

Loc: Kuranda, Queensland.
Type: B.M.

xanthostigma Szépligeti
Szépligeti (1900: 61) ♀ descr.
Turner (1918*c:* 221) note.
Loc: Kuranda, Mackay, Queensland; also New Guinea.
Type: N.H.M.

Genus **Disophrys** Foerster, 1862

diluta Turner
Turner (1918*c:* 228) ♀ descr., key.
Loc: Mackay (type), Kuranda, Queensland.
Type: B.M.

diversipes Turner
Turner (1918*c:* 227) ♀ descr., key.
Loc: Kuranda (type), Mackay, Queensland.
Type: B.M.

exornata Turner
Turner (1918*c:* 227) ♀ descr., key.
Loc: Kuranda, Queensland.
Type: B.M.

nigropectus Turner
Turner (1918*c:* 229) ♀ descr., key.
Loc: Kuranda, Queensland.
Type: B.M.

ruberrima Turner
Turner (1918*c:* 226) ♀ descr., key.
Loc: Mackay (type), Townsville, Queensland.
Type: B.M.

rufifrons Turner
Turner (1918*c:* 226) ♀ descr., key.
Loc: Port Essington, Northern Territory.
Type: B.M.

signatipennis Turner
Turner (1918*c:* 225) ♂ descr.
Loc: Kuranda, Queensland.
Type: B.M.

similipicta Turner
Turner (1918*c:* 228) ♀ descr., key.
Loc: Mackay (type) Townsville, Queensland.
Type: B.M.

Genus **Platyagathis** Turner, 1918

leaena Turner
Turner (1918*a:* 114) ♂ ♀ descr., new genus.
Loc: Yallingup, S.W. Australia.
Type: B.M.

Subfamily *MICROGASTERINAE*

All the species of this subfamily appear to be internal parasites of lepidopterous larvae.

Genus **Adelius** Haliday, 1833

australiensis (Ashmead)
Ashmead [*Acoelius*] (1900: 358) ♀ descr.
Loc: Australia.
Type: U.S.N.M. (No. 4911).

Genus **Apanteles** Foerster, 1862

anthelae Wilkinson
Wilkinson (1932*a:* 335) ♂ ♀ descr., key.
Loc: Victoria.
Host: *Anthela ocellata* Walker (Anthelid.).
Type: B.M.

australiensis Ashmead
Ashmead (1900: 356) ♀ descr.
Wilkinson (1930: 485) host.
Wilkinson (1932*a:* 334) key.
Loc: New South Wales, Victoria.
Host: *Antheraea eucalypti* Scott (Saturniid.).
Type: U.S.N.M. (No. 4931).

biroi Szépligeti
Szépligeti (1905: 49) descr.
Wilkinson (1928: 121) ♂ ♀ descr., key.
Wilkinson (1932*a:* 337) key.
Loc: Sydney, New South Wales.
Type: N.H.M.

deliadis Bingham
Bingham (1906: 125) ♂ ♀ descr., host.
Wilkinson (1932*a:* 334) ♂ ♀ descr., key.
Loc: Townsville, Queensland.
Host: *Delias argenthona* Fabr. (Pierid.).
Type: H.D.O.M.

flavipes (Cameron)
Cameron [*Cotesia*] (1891: 185) descr.
Olliff [*Apanteles nonagriae*] (1893: 381) descr., fig.

Wilkinson (1928*a:* 93) ♂ ♀ descr.
Wilkinson [*A. nonagriae*] (1928*a:* 136) descr.
Wilkinson (1929*a:* 108) descr.
Wilkinson (1932: 337) key.
Wilkinson (1934*b:* 156) key.
Loc: Australia; also India and Formosa.
Host: *Phragmatiphila truncata* Walk. (Noctuid.).
Type: B.M.

glomeratus (Linnaeus)
Linnaeus [*Ichneumon*] (1758: 568) descr.
Wilkinson (1932*a:* 334) key.
Loc: Nearly cosmopolitan; introduced into Australia.
Hosts: *Pieris rapae* (Linn.) (Pierid.).
P. brassicae (Linn.) (Pierid.).
Type: N.K.

guyanensis Cameron
Cameron (1911: 327) ♂ ♀ descr.
Wilkinson (1930: 483) host., key.
Loc: Western Australia; also British Guiana.
Host: Probably *Utsthesia pulchella* Lis. (Arctiid.).
Type: B.M.

philoeampus Cameron
Cameron (1911: 342) ♀ descr.
Wilkinson (1928*c:* 96) descr.
Wilkinson (1932*a:* 333) key.
Loc: Wattle Flat, New South Wales.
Type: B.M.

radiantis Wilkinson
Wilkinson (1929*a:* 110) ♂ ♀ descr., host.
Wilkinson (1932*a:* 334) key.
Loc: Gatton, Queensland.
Host: *Euxoa radians* Guen. (Noctuid.).
Type: B.M.

rubecula Marshall
Marshall (1885: 175) ♀ descr.
Marshall (1889: 420) ♀ descr.
Wilkinson (1932*a:* 334) key, Austr. record.
Loc: Europe; Australia; New Zealand.
Host: *Pieris rapae* Linn. (Pierid.).
Type: N.K.

ruficrus (Haliday)
Haliday [*Microgaster*] (1835: 253) ♂ ♀ descr.
Ashmead [*Apanteles antipoda*] (1900: 355) ♂ ♀ descr., host.
Tryon (1900: 142) descr., host fig.
Cameron [*A. sydneyensis*] (1911: 342) ♀ descr., host.
Viereck [*A. narangae*] (1913: 642) descr.
Wilkinson [*A. antipoda*] (1928: 95) descr.
Gahan (1928: 256) syn.
Wilkinson (1929*b:* 108) note, syn.
Wilkinson (1932: 333) syn., key.
Loc: Nearly cosmopolitan; Queensland; New South Wales.
Hosts: *Heliothis armigera* Hubn. (Noctuid.).
Agrotis sp. (Ashmead) (Noctuid.).
Plusia sp.? (Cameron) (Noctuid.).
Leucania unipuncta Haworth (Noctuid.).
Type: N.K. (type *A. antipoda* Ash., U.S.N.M. No. 4912).

rufiventris (Bingham)
Bingham [*Protapanteles*] (1906: 127) ♂ ♀ descr., host.
Wilkinson (1932*a:* 335) key, host.
Loc: Townsville, Queensland.
Type: H.D.O.M.
Host: *Ogyris genoveve* How. (Lycaenid.).

sicarius Marshall
Marshall (1885: 209) ♂ ♀ descr.
Wilkinson (1932*a:* 337) key.

tasmanica Cameron
Cameron (1912: 196) ♀ descr.
Wilkinson (1932*a:* 337) ♂ ♀ key.
Dumbleton (1940: 325a) host, N. Z. record.
Dumbleton (1935: 572) host, biol., fig.
Loc: Tasmania; New Zealand.
Type: B.M.
Host: *Tortrix postvittana* Walk. (Tortricid.).

Genus MICROGASTER Latreille, 1804

magnifica Wilkinson
Wilkinson (1929*a:* 120) ♂ ♀ descr., key.
Loc: Queensland.
Type: B.M.

morata Wilkinson

Wilkinson (1929*a:* 106) ♂ ♀ descr., key.
Loc: Victoria.
Host: *Thyridopteryx herrichi* Westr. (Psychid.).
Type: B.M.

perniciosa Wilkinson
Wilkinson (1929*a:* 112) ♀ descr., key.
Loc: Victoria.
Type: B.M.

petiolaris Szépligeti
Szépligeti (1905: 48) ♂ ♀ descr.
Wilkinson (1929*a:* 104) ♂ ♀ descr., key.
Loc: New South Wales.
Type: N.H.M.

resplendens Wilkinson
Wilkinson (1929*a:* 106) ♀ descr., key.
Loc: Mt. Wellington, Tasmania (2,000 ft.)
Type: B.M.

rixosa Wilkinson
Wilkinson (1929*a:* 108) ♂ ♀ descr., key.
Loc: New South Wales.
Type: B.M.

sons Wilkinson
Wilkinson (1932*b:* 87) descr., fig.
Loc: Brindabella, A.C.T.
Type: N.C.A.

tearae Wilkinson
Wilkinson (1929*a:* 107) ♀ descr., key., host.
Loc: Australia.
Host: *Teara tristis* Lewin (Notodontid.).
Type: B.M.

tegularis Szépligeti
Szépligeti (1905: 49) ♂ descr.
Wilkinson (1928*a:* 105) ♂ descr., key.
Loc: New South Wales.
Type: N.H.M.

vulpina Wilkinson
Wilkinson (1929*a:* 109) ♂ ♀ descr., key.
Loc: Victoria.
Type: B.M.

Genus **Microplitis** Foerster, 1862

basalis (Bingham)
Bingham [*Microgaster*] (1906: 125) ♂ descr.
Dodd [*Microgaster*] (1906: 120) host.
Wilkinson (1929*a:* 122) ♂ ♀ descr.
Wilkinson (1930*a:* 24) host.
Loc: Queensland.
Host: *Theratra oldenlandiae* Walk.
Type: H.D.O.M.

demolitor Wilkinson
Wilkinson (1934*a:* 119) ♂ ♀ descr., host.
Loc: Stanthorpe, Queensland.
Hosts: *Heliothis obsoleta* Fabr. (Noctuid.). *H. armigera* Hubn. (Noctuid.).
Type: B.M.

perelegans (Bingham)
Bingham [*Microgaster*] (1906: 126) ♂ ♀ descr.
Dodd [*Microgaster*] (1906: 120) host.
Wilkinson (1929*a:* 122).
Wilkinson (1930*a:* 24) host.
Loc: North Queensland.
Host: *Pheressaces cycnoptera* Lowes (Notodontid.).
Type: H.D.O.M.

Subfamily *CARDIOCHILINAE*

There are no host records from Australia, but, from the few host records available from other countries, the species of this family apparently parasites lepidopterous larvae.

Genus **Cardiochiles** Nees, 1818

assimilator Turner
Turner (1918*b:* 49) ♂ ♀ descr.
Loc: Kuranda, Mackay, Queensland.
Type: B.M.

dissimulator Turner
Turner (1918*b:* 50) ♀ descr., key.
Loc: Thursday Island, Queensland.
Type: B.M.

rufator Romans
Romans (1915: 17) ♀ descr.
Loc: Kimberley, N.W. Australia.
Type: N.H.M.S.

uniformis Turner
Turner (1918*b:* 51) ♂ ♀ descr., key.
Loc: Mackay, Queensland.
Type: B.M.

verticalis Turner
Turner (1918*b:* 51) ♀ descr.
Loc: Mackay, Queensland.

Type: B.M.

Subfamily *CHELONINAE*

Parasites of lepidopterous larvae. Eggs are laid in eggs of the hosts but the larvae of the parasite do not become mature until the hosts have reached maturity.

Genus ASCOGASTER Wesmael, 1835

abdominalis Szépligeti
Szépligeti (1908*b:* 319) ♀ descr.
Loc: S.W. Australia.
Type: N.H.M.

antennalis Szépligeti
Szépligeti (1908*b:* 319) descr.
Loc: S.W. Australia.
Type: N.H.M.

australiensis Szépligeti
Szépligeti (1905: 47) descr.
Loc: S.W. Australia.
Type: N.H.M.

caudata Szépligeti
Szépligeti (1905: 46) descr.
Loc: Australia.
Type: N.H.M.

cinctus Baker
Baker (1926: 477) ♀ descr., key.
Loc: New South Wales.
Type: U.S.N.M.

detectus Baker
Baker (1926: 478) ♂ descr., key.
Loc: New South Wales.
Type: U.S.N.M.

distinctus Baker
Baker (1926: 481) ♀ descr., key.
Loc: New South Wales.
Type: U.S.N.M.

erythropus Cameron
Cameron [*Areogaster*] (1911: 340) ♀ descr.
Loc: Mittagong, New South Wales.
Type: B.M.
Note: *Areogaster*, which occurs in Cameron, 1911, is an evident typographical error for *Ascogaster*.

intensus Baker
Baker (1926: 473) ♂ descr., key.
Loc: New South Wales.
Type: U.S.N.M.

laeviventris Baker
Baker (1926: 475) ♀ descr., key.
Loc: New South Wales.
Type: U.S.N.M.

maculaticeps Baker
Baker (1926: 482) ♂ descr., key.
Loc: New South Wales.
Type: U.S.N.M.

modestus Baker
Baker (1926: 474) ♀ descr., key.
Loc: New South Wales.
Type: U.S.N.M.

palpalis Szépligeti
Szépligeti (1905: 46) descr.
Loc: Australia.
Type: N.H.M.

tegularis Szépligeti
Szépligeti (1905: 46) descr.
Loc: Australia.
Type: N.H.M.

tricolor Szépligeti
Szépligeti (1905: 46) descr.
Loc: Mt. Victoria, New South Wales.
Type: N.H.M.

vividus Baker
Baker (1926: 479) ♂ descr., key.
Loc: New South Wales.
Type: U.S.N.M.

Genus CHELONUS Panzer, 1806

australiensis Szépligeti
Szépligeti (1905: 46) descr.
Loc: New South Wales.
Type: N.H.M.

coriaceus Szépligeti
Szépligeti (1905: 45) descr.
Loc: New South Wales.
Type: N.H.M.

megaspilus Cameron
Cameron (1911: 341) ♀ descr.
Loc: Tamworth, New South Wales.
Type: B.M.

similis Szépligeti
Szépligeti (1905: 44) descr.
Loc: New South Wales.
Type: N.H.M.

unimaculatus Szépligeti
Szépligeti (1905: 45) descr.
Loc: New South Wales.
Type: N.H.M.

Genus PHANEROTOMA Wesmael, 1838

australiensis Ashmead
Ashmead (1900: 354) ♀ descr.
Roman (1915: 17) ♂ descr., noted.
Loc: Broome, W. Australia (Roman).
Type: U.S.N.M. (No. 4904).
leeuwinensis Turner
Turner (1917: 247) descr.
Loc: Australia.
Type: B.M.

Genus SIGALPHUS Latreille, 1802

conjugator (Turner)
Turner [*Sphaeropyx*] (1917: 245) descr.
Loc: Australia.
Type: B.M.
tripartitus Szépligeti
Szépligeti (1905: 43) descr.
Loc: New South Wales.
Type: N.H.M.

Subfamily *OPIINAE*

The species of this subfamily are, with few if any exceptions, parasitic on Diptera. Some species are important in the biological control of fruit-flies.

Genus OPIUS Wesmael, 1835

Refer to Muesebeck (1951: 153) for the generic synonymy.
albimanus Szépligeti
Szépligeti (1905: 54) descr.
Loc: New South Wales.
Type: N.H.M.
brevicaudis Szépligeti
Szépligeti (1905: 25) descr.
Loc: New South Wales.
Type: N.H.M.
carpocapsae (Ashmead)
Ashmead [*Diachasma*] (1900: 357) descr.
Szépligeti [*Diachasma*] (1904: 162) listed.
Loc: New South Wales; New Zealand.
Host: Probably *Dacus tryoni* (Froggatt) (Trypetid.).
Type: U.S.N.M. (No. 4914).
deeralensis Fullaway
Fullaway (1950: 65) descr., host.
Fullaway (1951: 244) note.
Loc: Deeral, Queensland.
Host: *Dacus laticaudus* Hardy.
Type: H.E.S.
fijiensis Fullaway
Fullaway (1950: 67) ♂ ♀ descr., host, recorded Australia.
Fullaway (1951: 244) descr., host.
Loc: Australia; Fiji; New Caledonia.
Host: *Dacus* sp.
Type: H.E.S.
froggatti Fullaway
Fullaway (1950: 67) descr., host.
Fullaway (1951: 250) note.
Loc: Deeral, Queensland; Atherton Tableland.
Host: *Dacus* sp.
Type: H.E.S.
kraussi Fullaway
Fullaway (1951: 249) ♂ ♀ descr., host.
Loc: Deeral, Queensland.
Host: *Dacus laticaudus* Hardy.
Type: H.E.S.
Note: Reared in Hawaii from fruit-fly pupae collected in Australia.
perkinsi Fullaway
Fullaway (1950: 66) descr., host.
Fullaway (1951: 244) listed, host.
Loc: Deeral, Queensland.
Host: *Dacus laticaudus* Hardy.
Type: H.E.S.
persulcatus (Silvestri)
Silvestri [*Biosteres*] (1916: 167) descr.
Fullaway (1950: 67) note, Australian record.
Loc: Australia.
Host: *Dacus* sp.
Type: N.K.
tryoni Cameron
Cameron (1911: 343) ♂ descr.
Gurney and Gallard (1910: 428) noted,. fig
Fullaway (1951: 243) noted, host.
Loc: New South Wales.

Hosts: *Dacus laticaudus* Hardy (Trypetid.).
Dacus ferrugineus Fabr. (Trypetid.).
Ceratitis capitata Wied. (Trypetid.).
Type: B.M.

Subfamily *BRACONINAE*
(= *Vipioninae* Vier.)

The members of this subfamily have a wide variety of hosts, many of which are important pests. Although Thomson's genus *Ipobracon* is closely related to, and considered by some authors to be synonymous with, Foerster's genus *Iphiaulax*. I am at present retaining the identity of *Ipobracon*.

Genus ATANYCOLUS Foerster, 1862

tomentosus Szépligeti
Szépligeti (1905: 25) descr.
Loc: Queensland.
Type: N.H.M.

Genus BRACON Fabricius, 1804–05

Froggatt (1916: 561) describes a species of *Bracon* reared from *Lyctus brunneus* infesting tea chests that were imported from India.

australasicus Cameron
Cameron (1912: 193) ♀ descr.
Loc: Australia.
Type: B.M.

australiensis Szépligeti
Szépligeti (1905: 38) descr.
Loc: Australia.
Type: N.H.M.

bimaculatus Szépligeti
Szépligeti (1905: 38) descr.
Loc: Australia.
Type: B.H.M.

bimaris Turner
Turner (1918*a:* 93) ♀ descr.
Loc: Tasmania.
Type: B.M.

capitator (Fabricius)
Fabricius [*Ichneumon*] (1775: 335) ♀ descr.
Fabricius (1804: 108) descr.
Dalla Torre (1898: 261) listed.
Szépligeti (1904: 37) listed.
Loc: Australia.
Type: B.M.

defensor (Fabricius)
Fabricius [*Ichneumon*] (1775: 335) ♀ descr.
Fabricius (1804: 108) descr.
Dalla Torre (1898: 262) listed.
Szépligeti (1904: 37) listed.
Loc: Australia.
Type: B.M.

eucalypti Cameron
Cameron (1911: 340) ♂ ♀ descr.
Loc: Sydney, New South Wales.
Type: B.M.
Note: Bred from reddish galls on leaves of eucalyptus.

froggatti Cameron
Cameron (1911: 339) ♀ descr.
Loc: Reedy Creek, near Inverell, New South Wales.
Type: B.M.

hartmeyeri Szépligeti
Szépligeti (1908: 317) descr.
Loc: S.W. Australia.
Type: N.H.M.

hebetor Say
Say (1836: 252) ♂ ♀ descr.
Kirby [*as brevicornis*] (1884: 31) descr.
Marshall [as *brevicornis*] (1885: 24) descr.
Ashmead [as *juglandis*] (1888: 621) descr.
Johnston [*Macrobracon*] (1895: 324)
Froggatt (1912: 310) descr., fig., host.
Myers [*Microbracon*] (1929: 425) recorded, host.
Loc: Nearly cosmopolitan; Australia.
Hosts: *Plodia interpunctella* Huebner.
Ephestia kuehniella Zeller.
Ephestia eluttella Huebner.
Galleria mellonella Linnaeus.
Type: *hebetor*, lost; *juglandis*, U.S.N.M.

hospitator Fabricius
Fabricius [*Ichneumon*] (1775: 335) descr.
Fabricius (1804: 106) descr.
Dalla Torre [*B. arvensis*] (1898: 37) listed.
Szépligeti (1904: 37) listed.
Loc: Australia.
Type: B.M.

levisulcatus Cameron
Cameron (1912: 194) ♂ descr.

Loc: Reedy Creek, Inverell, New South Wales.
Type: B.M.

pilitarsis Cameron
Cameron (1912: 193) ♀ descr.
Loc: Reedy Creek, Inverell, New South Wales.
Type: B.M.

pulchellus Brullé
Brullé (1846: 432) descr.
Froggatt (1890: 713) listed.
Dalla Torre (1898: 285) listed.
Szépligeti (1904: 37) listed.
Loc: Australia.
Type: N.K.

thalpocharis Ashmead
Ashmead (1900: 359) ♂ ♀ descr.
Szépligeti [*B. talpocharis*] (1904: 46) listed [error in spelling.]
Froggatt [*Microbracon thalpocaris*] (1907: 87) descr.
Loc: Australia.
Host: *Thalpocharis coccophaga* Walker.
Type: U.S.N.M. (No. 4915).

tricolor Ashmead
Ashmead [*Microbracon*] (1900: 359) ♀ descr.
Szépligeti (1904: 46) listed.
Loc: Australia.
Type: U.S.N.M. (No. 4916).

turneri Cameron
Cameron (1906: 26) ♂ descr.
Loc: Australia.
Type: N.K.

walkeri Turner
Turner (1918*a:* 93) ♀ descr.
Loc: Queensland; Northern Territory.
Type: B.M.

Genus **Campyloneurus** Szépligeti, 1906

australiensis (Szépligeti)
Szépligeti [*Iphiaulax*] (1901: 369) descr.
Szépligeti (1906: 561) n. gen.
Turner (1918*a:* 100) key.
Loc: Australia.
Type: N.H.M.

biplicatus Roman
Roman (1915: 12) ♀ ♂ descr.
Loc: Kimberley District, N.W. Australia.
Type: N.H.M.S.

mutator (Fabricius)
Fabricius [*Ichneumon*] (1775: 335) descr.
Fabricius [*Bracon*] (1804: 109) descr.
Brullé [*Myosoma*] (1846: 453) descr.
Froggatt [*Myosoma*] (1890: 710) listed.
Dalla Torre [*Myosoma*] (1898: 255) listed, loc. error.
Turner (1918*a:* 100) nomenclature.
Loc: Queensland.
Type: B.M.

praeclarus Turner
Turner (1918*a:* 101) ♀ descr., key.
Loc: Queensland.
Type: B.M.
Note: Very near *C. profugus* Turner, of which it may be a variety (Turner 1918*a:* 101).

praepotens Turner
Turner (1918*a:* 101) ♀ descr., key.
Loc: Queensland.
Type: B.M.

profugus Turner
Turner (1918*a:* 100) ♀ descr., key.
Loc: Queensland.
Type: B.M.

Genus **Cyanopterus** Haliday, 1835

calligaster Roman
Roman (1915: 16) ♀ descr.
Loc: Fremantle, W. Australia.
Type: N.H.M.S.

crassicaudis Szépligeti
Szépligeti [*Bracon*] (1901: 397) descr.
Szépligeti [*Iphiaulax*] (1904: 21) listed.
Turner (1918*a:* 94).
Loc: Doubtful, probably Australia.
Type: N.H.M.
Note: This may be synonymous with *C. profiscator* (Fabr.) (Turner 1918*a:* 94).

innotatus Turner
Turner (1918*a:* 95) ♀ descr., key.
Loc: Queensland.
Type: B.M.

proficiscator (Fabricius)
Fabricius [*Ichneumon*] (1775: 335) descr.
Fabricius [*Bracon*] (1804: 105) descr.
Szépligeti [*Bracon*] (1904: 37) listed.
Turner (1918*a:* 94) noted, synonymy, key.
Loc: Australia.
Type: B.M.
rufus Szépligeti
Szépligeti [*Iphiaulax*] (1901: 397) descr.
Szépligeti [*Iphiaulax*] (1904: 23) listed.
Szépligeti (1906: 586) genus changed.
Turner (1918*a:* 95) noted, key.
Loc: New South Wales.
Type: N.H.M.

Genus **HYBOGASTER** Szépligeti, 1906

australiensis (Ashmead)
Ashmead [*Iphiaulax*] (1900: 360) ♂ descr.
Szépligeti (1904: 23) listed.
Roman (1915: 15) ♂ ♀ noted, nomenclature.
Loc: Australia, Kimberley (Roman).
Type: U.S.N.M. (No. 4918).

Genus **IPHIAULAX** Foerster, 1862
(= *Ipobracon* Dalla Torre, 1898)

afer Szépligeti
Szépligeti (1905: 29) descr.
Loc: Australia.
Type: N.H.M.
australis Szépligeti
Szépligeti (1901: 369) ♂ descr.
Szépligeti (1904: 23) listed.
Loc: Australia.
Type: N.H.M.
bifasciatus Szépligeti
Szépligeti (1905: 28) descr.
Loc: Australia.
Type: N.H.M.
bipartitus Szépligeti
Szépligeti (1905: 35) descr.
Loc: Australia.
Type: N.H.M.
bisignatus Szépligeti
Szépligeti (1905: 29) descr.
Loc: Australia.
Type: N.H.M.
camerunensis Szépligeti
Szépligeti (1905: 29) descr.
Loc: Australia.
Type: N.H.M.
crenulatus Szépligeti
Szépligeti (1905: 34) descr.
Loc: Australia.
Type: N.H.M.
cristatus Szépligeti
Szépligeti (1905: 30) descr.
Loc: Australia.
Type: N.H.M.
limbatus (Brullé)
Brullé [*Bracon*] (1846: 433) ♀ descr.
Froggatt [*Bracon*] (1891: 713) listed.
Ashmead [*Callibracon*] (1900: 358) descr. n. gen.
Szépligeti (1904: 23) listed.
Froggatt [*Bracon*] (1907: 86) descr.
Loc: Australia.
Type: N.K.
longicornis Szépligeti
Szépligeti (1905: 32) descr.
Loc: Australia.
Type: N.H.M.
longiseta Szépligeti
Szépligeti (1905: 28) descr.
Loc: Australia.
Type: N.H.M.
micans Szépligeti
Szépligeti (1905: 35) descr.
Loc: Australia.
Type: N.H.M.
perspicax Szépligeti
Szépligeti (1905: 32) descr.
Loc: Australia.
Type: N.H.M.
pretiosus Szépligeti
Szépligeti (1905: 36) descr.
Loc: Australia.
Type: N.H.M.
pulchricaudis Szépligeti
Szépligeti (1905: 30) descr.
Loc: Australia.
Type: N.H.M.
rubriceps Froggatt
Froggatt (1916: 564) ♀ descr., fig.

Froggatt (1923: 40) descr., fig., host.
Loc: New South Wales.
Host: *Trogodendron fasciculatum* Schreibers (yellow-horned clerid.).
Type: N.K.

ruficeps Szépligeti
Szépligeti (1905: 33) descr.
Loc: Australia.
Type: N.H.M.

scoparius Szépligeti
Szépligeti (1905: 31) descr.
Loc: Australia.
Type: N.H.M.

semirufus Szépligeti
Szépligeti (1905: 33) descr.
Loc: Australia.
Type: N.H.M.

speciosissimus Szépligeti
Szépligeti (1905: 31) descr.
Loc: Australia.
Type: N.H.M.

transiens Turner
Turner (1918*a:* 95) ♂ ♀ descr.
Loc: Queensland; Northern Territory; N.W. Australia.
Type: B.M.

trifasciatus Szépligeti
Szépligeti (1905: 31) descr.
Loc: Australia.
Type: N.H.M.

trinotata Ashmead
Ashmead (1900: 359) ♂ descr.
Szépligeti (1904: 23) listed.
Loc: Australia.
Type: U.S.N.M. (No. 4917).

Genus IPOBRACON Thomson, 1892

emeraldensis Fahringer
Fahringer (1942: 40) descr.
Loc: Australia.
Type: N.H.M.

flaviceps (Cameron)
Cameron [*Poecilobracon*] (1901*a:* 122) ♂ descr.
Szépligeti [*Iphiaulax*] (1904: 23) listed.
Turner (1918*a:* 105) descr., variety.
Loc: Australia.
Type: B.M.

flaviceps Roman **mackayensis** Turner
Turner (1918*a:* 105) descr.
Loc: Queensland.
Type: B.M.

fraterculus Turner
Turner (1918*a:* 105) ♀ descr.
Loc: S.W. Australia.
Type: B.M.

gilberti Turner
Turner (1918*a:* 104) ♀ descr.
Loc: Queensland.
Type: B.M.

ingressor Turner
Turner (1918*a:* 102) ♀ descr.
Loc: Queensland.
Type: B.M.

pallidicolor Turner
Turner (1918*a:* 102) ♂ ♀ descr.
Loc: Queensland.
Type: B.M.

punctistigma Roman
Roman (1915: 10) ♀ descr.
Loc: Kimberley District, N.W. Australia.
Type: N.H.M.S.

quadricolor Turner
Turner (1918*a:* 103) ♀ descr.
Loc: Queensland.
Type: B.M.

torridus Turner
Turner (1918*a:* 104) ♀ descr.
Loc: Queensland.
Type: B.M.

Genus MACROBRACON Szépligeti, 1902

nobilis Turner
Turner (1918*a:* 96) ♂ ♀ descr.
Loc: Queensland.
Type: B.M.

Genus MEGALOMMUM Szépligeti, 1900

annulatum Turner
Turner (1918*a:* 97) ♂ ♀ descr.
Loc: S.W. Australia; Tasmania.
Type: B.M.

Genus **MERINOTUS** Szépligeti, 1906

xanthocephalus Turner
Turner (1918*a:* 98) ♂ ♀ descr.
Loc: Queensland.
Type: B.M.
Note: This genus is very near, if not identical with, *Sigalphogaster* Cameron.

Genus **MONOCOILA** Roman, 1910

parva Roman
Roman (1915: 13) ♀ descr.
Loc: Kimberley, N.W. Australia.
Type: N.H.M.S. [Not marked as type.]

Genus **PLATYBRACON** Szépligeti, 1900

nigriceps Cameron
Cameron (1911: 338) ♀ descr.
Loc: Gin Gin, Queensland.
Type: B.M.

Genus **STIGMATOBRACON** Turner, 1918

basipennis Turner
Turner (1918*a:* 92) ♀ descr., key.
Loc: Queensland.
Type: B.M.

diversipennis Turner
Turner (1918*a:* 92) ♀ descr., key.
Loc: Victoria.
Type: B.M.

torresensis Turner
Turner (1918*a:* 93) ♂ descr., key.
Loc: Cape York, Queensland.
Type: B.M.

xanthostigma Turner
Turner (1918*a:* 92) descr., key.
Loc: Queensland.
Type: B.M.

Genus **VIPIO** Latrielle, 1905

gestroi Mantero
Mantero (1897: 119) ♀ descr.
Dalla Torre (1898: 305) listed.
Szépligeti (1904: 14) listed.
Loc: Australia.
Type: N.K.

Subgenus **VIPIELLUS** Roman, 1915

mjobergi Roman
Roman (1915: 8) ♀ descr.
Loc: Kimberley, N.W. Australia.
Type: N.H.M.S.

Subfamily *SPATHIINAE*

As far as is known at present, the species of this family are external parasites on coleopterous larvae.

Genus **LEPTOSPATHIUS** Szépligeti, 1902

formosus Szépligeti
Szépligeti (1902: 49) ♂ ♀ descr., genotype.
Szépligeti (1904: 54) listed.
Loc: Australia.
Type: N.H.M.

Genus **SPATHIUS** Nees, 1818

apicalis Westwood
Westwood (1882: 43) ♀ descr.
Wilkinson [*S. festinans*] (1931*a:* 261) ♂ ♀ descr.
Nixon (1943*b:* 378) descr., key, Austr. record.
Loc: Kuranda, Queensland; India.
Type: N.K.

iridescens (Schletterer)
Schletterer [*Stenophasmus*] (1889: 203) ♂ descr.
Szépligeti (1904: 53) listed, nomenclature.
Wilkinson (1931*b:* 526) noted.
Loc: Cape York, Queensland; Sydney, New South Wales.
Types: N.H.M.V., S.C.G.M.

kurandaensis Nixon
Nixon (1943*b:* 393) descr., key.
Loc: Kuranda, Queensland.
Type: B.M.

turneri Nixon
Nixon (1943*b:* 370) descr.
Loc: Tambourine Mountains, S.E. Queensland.
Type: B.M.

sp. ?
Froggatt (1927: 55–56) recorded and figured.
Loc: New South Wales.
Note: Collected from imported tea chests infested by a *bostrychid* beetle.

Subfamily *HECABOLINAE*

Genus **Heterospilus** Haliday, 1862

asion Nixon
Nixon (1943*a:* 260) ♂ ♀ descr., fig.
Loc: Maryborough and Imbil, Queensland.
Host: *Xylopsocus gibbicollis* (Bostrychid.).
Type: B.M.

Genus **Monolexis** Foerster, 1862

atis Nixon
Nixon (1943*a:* 261) ♂ ♀ descr., fig.
Loc: Atherton, Palm Is., Queensland.
Host: *Lyctus brunneus* (Lyctid.).
Type: B.M.
Note: "It is possible that my new species is a European insect which has been introduced with *Lyctus brunneus* for I have examined a single specimen, a female (Italy, bred from *Bostrychid* in figs) which appears to be identical with *atis*." (Nixon, 1943*a:* 262.)

Subfamily *EXOTHECINAE*

Genus **Opiopterus** Szépligeti, 1908

parvus Szépligeti
Szépligeti (1908: 318) descr., genotype.
Loc: S.W. Australia.
Type: N.H.M.

Genus **Spinaria** Brullé, 1846

aliciae Turner
Turner (1917: 244) descr.
Loc: Australia.
Type: B.M.

Genus **Xenarcha** Foerster, 1862

tricolor Szépligeti
Szépligeti (1908: 318) descr.
Loc: S.W. Australia.
Type: N.H.M.

Subfamily *ROGADINAE*

The majority of the species of this subfamily are parasitic on lepidopterous larvae

Genus **Rogas** Nees, 1818
(= *Rhogas* Agassiz 1846)

politus Szépligeti
Szépligeti (1906: 617) descr.
Loc: Australia.
Type: N.H.M.

tricolor Haliday
Haliday (1836: 98) descr.
Szépligeti (1904: 87) listed.
Loc: Australia.
Type: N.K.

Subfamily *DORYCTINAE*

Most species of this family are external parasites of coleopterous larvae.

Genus **Acanthodoryctes** Turner, 1918

gilberti Turner
Turner (1918*b:* 56) ♀ descr., key.
Loc: Mackay, Queensland.
Type: B.M.

morleyi (Froggatt)
Froggatt [*Iphiaulax*] (1916: 566) ♀ descr., host.
Froggatt [*Iphiaulax*] (1923: 42) descr.,host.
Turner (1918*b:* 56) noted, genotype.
Loc: East Coast, Australia.
Host: *Trogodendron fasciculatum* (Clerid.).
Type: B.M.

Genus **Caenopachyella** Szépligeti, 1908

lutea Szépligeti
Szépligeti (1908: 399) ♂ ♀ descr., genotype.
Loc: New South Wales.
Type: N.H.M.

Genus **Doryctes** Haliday, 1836

laemosacci Nixon
Nixon (1943: 257) ♀ descr., host
Loc: Emu Valley, Queensland.
Host: *Laemosaccus* sp. (Curculionid.).
Type: B.M.

parvus Muesebeck
Muesebeck (1941: 150) ♂ ♀ descr.
Loc: Queensland, Australia. The type locality is Mayaguez, Puerto Rico.
Type: U.S.N.M. No. 55678.
Host: *Dinoderus minutus* (Fabr.) (Type) *Lyctus* sp. (Queensland.)

Note: This is rather a common species in various tropical regions of the world.

syagrii (Fullaway)
Fullaway [*Ischiogonus*] (1922: 201) ♂ ♀ descr., host.
Loc: New South Wales.
Host: *Syagrius fulvitarsis* Pasc. (fern weevil).
Type: N.K.
Note: Fullaway (1921: 101, 114) records a species of *Doryctes* parasitic on the fern weevil (*Syagrius fulvitarsis*) from New South Wales. This probably is the same species as recorded above.

Genus **LIODORYCTES** Szépligeti, 1906

atriceps Turner
Turner (1918*b:* 54) ♀ descr., key.
Loc: Mackay, Queensland.
Type: B.M.

australiensis (Szépligeti)
Szépligeti [*Acanthobracon*] (1902: 48) ♂ descr.
Szépligeti [*Neotrimorus*] (1904: 64) listed.
Szépligeti (1906: 599) noted, genotype.
Turner (1918*b:* 55) noted.
Loc: Cooktown, Kuranda, Mackay, Queensland.
Type: B.M.

erythrothorax Turner
Turner (1918*b:* 54) ♂ ♀ descr., key.
Loc: Mackay, Queensland.
Type: B.M.

nigridorsalis Turner
Turner (1918*b:* 53) ♀ descr., key.
Loc: Port Darwin, Australia.
Type: B.M.

Genus **SYNGASTER** Brullé, 1846

annulicornis Brullé
Brullé (1846: 454) descr.
Froggatt (1890: 714) listed.
Szépligeti (1904: 67) listed.
Turner (1918*b:* 57) noted.
Loc: Australia.
Type: N.K.
Note: Turner (1918*b:* 57) had not seen this species, and is doubtful of its true generic position.

lepidus Brullé
Brullé (1846: 459) descr.
Froggatt (1890: 714) listed.
Szépligeti [*S. lepida*] (1904: 67) listed [error in spelling.]
Cameron (1912: 195).
Turner (1918*b:* 57) noted.
Loc: S.E. Australia; Tasmania.
Type. N.K.

INTRODUCED SPECIES

I am indebted to Mr. Frank Wilson, Principal Research Officer, C.S.I.R.O., Entomology Division, for the following list of braconids introduced into Australia in connection with biological control. No information is available on the extent to which they have become established in the various localities in which they were liberated.

**Apanteles rubecula* Marshall.
**Apanteles glomeratus* Linn.
Ascogaster carpocapsae Vier. (*A. quadridentatus* Wesm.)
Bassus diversus (Mues.) (*Agathis diversus*)
Chelonus phthorimaeae Gahan
**Macrocentrus ancylivorus* Rohwer
Microbracon gelechiae Ashmead (*Bracon gelechiae*)
Triaspis thoracicus (Say) (*T. sayi* Mues. and Walkley.)

The above species are listed under the names by which they are generally referred to in the literature, the correct nomenclature is given in parentheses where this is different.

Species that have become definitely established are marked with an asterisk and included in the body of the catalogue.

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Studies on the Bathypelagic Fishes of the Family Paralepididae. 1. Survey of the Genera

ROBERT R. HARRY[1]

INTRODUCTION

THE PARALEPIDIDAE are large-eyed, elongate fishes lacking light organs and are members of the suborder Alepisauroidea (Alepisaurina, using the recently proposed endings of Stenzel, 1950: 94) of the order Iniomi (also called Scopeliformes by Berg, 1940: 256; Iniomida by Schultz, 1948: 233; Iniomida or Myctophida, using Stenzel's endings). These abundant pelagic and deep-sea teleosts of worldwide distribution have been termed barracudinas by Fowler (1936). The family appears to be most closely related to the Anotopteridae and Alepisauridae.

While I was endeavoring to determine the relationships of a new species of the genus *Lestidium* from off the coast of central California, it became evident that the classification of the Pacific paralepidids was in deplorable confusion, especially in regard to generic grouping. Comparison of the form and development of various parts of the body in the different genera has shown, unexpectedly, that certain structures not heretofore used are of phylogenetic or taxonomic importance. Among the most useful are the structure of the maxillaries, the form and distribution of the dentition and gillrakers, modifications of squamation, and variation of the lateral-line tube. These new observations form the basis for this revision of the Paralepididae.

In addition, these fish form an important food of tunas and other large oceanic fishes. A more complete knowledge of them, particularly in regard to speciation and limits of distribution, would furnish a valuable tool for obtaining information on the migration of these larger food fishes by means of stomach analyses.

In the course of the present study I have been able to examine material totaling several hundred specimens, representing all the known genera (*Sudis*, *Notolepis*, *Paralepis*, *Lestidium*, *Macroparalepis*, *Arctozenus*, *Bathysudis*, and *Lestidiops*), and all the generic types. One genus and one species are described as new. The revision is divided into parts comprising (1) a survey of the genera, (2) a review of the North Pacific species, and (3) a synopsis of the South Pacific species. The illustrations are by the author.

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New York Zoological Society, Dr. Kiyomatsu Matsubara of Kyoto University, Mr. John W. Reintjes of the Pacific Oceanic Fishery Investigations, Dr. Daniel Merriman of the Bingham Oceanographic Institute, Dr. Enrico Tortonese of the Università di Torino, and Mr. George Vanderbilt of Honolulu. The officers of the California Academy of Sciences, Stanford University, New York Zoological Society, Scripps Institution of Oceanography, United States National Museum, Academy of Natural Sciences of Philadelphia, and Pacific Oceanic Fishery Investigations Laboratory, Honolulu, have allowed me to examine all their collections of the family Paralepididae.

The work was done in the Natural History Museum of Stanford University and in the Research Laboratory of the George Vanderbilt Collections of the California Academy of Sciences.

HISTORY OF GENERIC CLASSIFICATION

The family Paralepididae has been variously expanded and restricted. It has, in the past, encompassed a wide assortment of remarkably divergent groups (*vide* Regan 1911, Parr 1928, Fowler 1944), but it is generally accepted by recent authors that the family includes only the genera *Paralepis*, *Lestidium*, *Macroparalepis*, and *Sudis*. The genus *Luciosudis* Fraser-Brunner belongs in the suborder Myctophoidea, probably in the family Chlorophthalmidae. The genus *Notosudis* Waite may belong in the suborder Alepisauroidea, but, if it does, it definitely does not belong in the Paralepididae. It is perhaps near the family Anotopteridae. The genus *Neosudis* Castelnau (1873) has not been rediscovered since the original account, and its systematic position is not known. Many characters are attributed to this genus which do not agree with the suborder Alepisauroidea as presently understood, and it is not included in the present study.

The recent workers who have contributed most toward a better understanding of the classification of the Paralepididae are Regan, Parr, Ege, and Maul.

Regan's arrangement of the order Iniomi (1911) has been generally accepted as the first reasonably natural system proposed for these forms. He relegated Paralepididae (using the name Sudidae, which he later sometimes abandoned in favor of Paralepididae) to the suborder Myctophoidea together with Synodontidae, Aulopidae, and Myctophidae. Unfortunately, he placed Sudidae in the wrong suborder because he based his family description on *Chlorophthalmus* instead of on *Sudis*, *Paralepis*, or a genus closely related to them. While *Chlorophthalmus* is obviously close to the three families Regan placed in the suborder Myctophoidea, its relationships to the paralepidids are distant. This unfortunate linkage of *Chloropththalmus* with the Paralepididae has contributed to the subsequent confusion of the subordinal relationships of the Myctophoidea and Alepisauroidea — confusion which has extended to the present. Actually it is clear that *Sudis* and its allies are more closely related to the Alepisauroidea than to the Myctophoidea and, therefore, should have been placed in the former suborder. Furthermore, Regan used Sudidae as a catch-all for forms that did not fit into his system, and he divided it into three groups containing nine genera which previous authors had apportioned to several families. Recent authors regard his third section, exclusive of *Parasudis*, as the only one of his three divisions that really belongs in the Paralepididae.

The most important extensive studies of the Iniomi have been those of Parr. In his survey of the Paralepididae (1928), he accepted and named Regan's three groups as subfamilies and added the problematical *Notosudis*, which was described subsequent to Regan's paper, as a fourth subfamily.

Parr's discussion of his "Paralepidini" includes a review of all genera and species (mostly prepared from the literature, as he had little material) but his entire classification was greatly revised, immediately after it appeared, in a series of papers by Ege and himself. Parr (1928) recognized only two genera

as valid, on the basis of the presence of scales in one genus and their absence in the other. Parr and Ege attempted by subsequent investigation to demonstrate that this type of division was not justified. The two reasons why Parr's classification of 1928 was not accepted by subsequent authors (including himself) are: (1) he did not recognize that *Sudis hyalina* was so distinct from all other paralepidids that it deserved monotypic generic status; (2) he based his generic characters for *Sudis* and *Lestidium* solely on the presence or absence of scales. It was not known at that time that the species of the family could be arranged in a uniformly graded series from (a) those completely scaled on head and body, through (b) those scaled only on body or head, through (c) those scaled only late in development, to (d) those lacking scales at all stages of development. Furthermore, he used the generic name *Sudis* for the scaled species, but the generic type (*hyalina*) is almost completely naked at all stages. In addition, each of his genera included both naked and scaled species.

Parr (1929: 4, 7) in a paper on the osteology and classification of the Iniomi, pursued further the relationships of the families. His investigations of the Paralepididae are based on the partial osteology of two representatives of "*Lestidium*" (*Paralepis brevirostris* and a species of *Lestidium*). It represents the first research of this kind on the family. Parr proposed a phylogenetic line on the basis of osteological characters, from *Chlorophthalmus* through *Bathysudis* to *Omosudis*, "thereby indirectly establishing a relationship between the Sudidae and Alepisauridae."

The generic relationships of the Paralepididae adopted by Parr (1928, 1929) and others were subsequently greatly modified on the basis of an extensive distributional and systematic research on the genus "*Paralepis*" of the North Atlantic by Ege (1930). His rich material was composed almost exclusively of larval to juvenile specimens. The identifications he made of these early stages with previously known adult forms are particularly valuable for the elucidation of the taxonomic and nomenclatural problems which had developed in the earlier literature. His generic classification is essentially the same as that used by most previous European authors. He retained the genus *Sudis* as monotypic and expanded the limits of *Paralepis*. Although the relationship of the genus *Lestidium* to *Paralepis* was considered by Ege to be a matter beyond the scope of his investigation, he maintained that the recognition of *Lestidium* on the premise of its being devoid of scales was completely untenable. The Mediterranean and North Atlantic material available to him was represented by young material completely devoid of scales; but he did not consider the lack of scales in the younger individuals necessarily to indicate their absence in the fully adult stage. For example, he found an individual of "*Paralepis rissoi*" (which is scaled when adult) 188 millimeters in length which completely lacked any trace of scales.

Unfortunately, Ege did not investigate the generic classification of the Paralepididae as carefully as he did the specific. He never defined the limits of the genus "*Paralepis*" as he accepted it, but apparently used it in the broad sense of early European authors. Actually he did not realize the bearing of *Lestidium* to his work. He claimed that the genus *Lestidium* was beyond the scope of his investigation, but included all species of this genus of which he had material in "*Paralepis*" and excluded almost all the others which he had not seen.

While he claimed that *Lestidium* is untenable on the basis of the lack of scales, Ege proved on morphometric grounds that the naked species can be recognized (*vide* the differentiation of groups I and II in his key). Apparently he never realized that his first division included all the scaly forms, and the second division all the forms naked even as adults. The mention of such discrepancies is not meant to detract from the value of his work. He was not concerned particularly with

the major classification of the family, but was primarily interested in development and speciation. In fact, he has made the Paralepididae the best-known group of the order Iniomi in this respect.

Ege's results were interpreted by Parr (1931*b*), who assumed that *Lestidium* was untenable and that the limits of the genus *Paralepis* had to be considerably extended to encompass a highly variable group—at least as long as practicable generic distinctions had not become re-established on a different morphological basis. Thus, if Parr's classification of 1928 were altered to fit this idea, all the species of "Paralepidini," except *Sudis hyalina*, would be placed in the genus *Paralepis*.

Ege (1933) preliminarily diagnosed 15 new species and a new genus, *Macroparalepis*, from a part of the paralepidid material collected—usually at great depths—by the 1928–30 "Dana" Expedition around the world. Unfortunately, the specimens are all postlarvae or juveniles, the descriptions are brief, and the relationships are not indicated for the species of *Macroparalepis*. *Lestidium* and *Paralepis* were compared with *Macroparalepis*. Dr. Ege is still studying this material and plans to publish more complete accounts.

Gregory and Conrad (1936: 28) also attempted to give a natural phylogeny of the order Iniomi. Their classification, which appears to have been done primarily by a comparison of illustrations of the species and superficial examination of the literature, adds little to our knowledge of the family Paralepididae. They apparently misinterpreted some of Parr's findings of 1929 and did not include the papers of Ege (1930, 1933) and Parr (1931).

Jensen (1942), in his critical review of the paralepidids of Greenland, gives important discussions of the genus *Paralepis*. One of the most important parts of his results is a detailed account of the structure of the lateral-line and scales. It is important to note that Jensen confuses the ossified sections of the lateral-line tube and the overlying lateral-line scales.

In a monograph of the paralepidid fishes in the collection of the Municipal Museum of Funchal, Madeira, Maul (1945) included material of *Sudis*, *Paralepis*, and *Macroparalepis* and confined the limits of the family to these genera. He presented definitions of the genera for the first time since Parr (1928). Maul described more adult material than any other recent worker and described larger specimens of *Macroparalepis* for the first time.

These classifications of Parr, Ege, and Maul differ essentially from my results, presented in the next section, in that I place *Sudis* in a distinct subfamily (Sudinae) and divide the Paralepidinae into two basic groups of genera that can be easily distinguished by osteological characters, by gillraker structure, by extent of squamation in the adults, and by morphometry. These two basic divisions of the Paralepidinae correspond to groups I and II of Ege's key (1930: 7). An outline of this classification is presented with the description of the paralepidids collected by the Bermuda Oceanographic Expeditions of the New York Zoological Society (Harry, 1951).

DISCUSSION

Family PARALEPIDIDAE

Paralepidini Bonaparte, 1832–41 (no pagination), 1846; Bellotti, 1878; Parr, 1928: 17, 32; Parr, 1929: 28.

Paralepidina Günther, 1864: 418.

Paralepididae Gill, 1874: 16; Gill, 1893: 131; Goode and Bean, 1895: 118.

Paralepidinae Jordan and Evermann, 1896: 599.

Paralepidae Dollo, 1908: 59; Jordan, 1923: 154.

Sudidae (in part) Regan, 1911: 125; Parr, 1928: 15; Parr, 1929: 27; Ege, 1933: 223; Fowler, 1944: 438.

Sudini Berg, 1940: 257, 437.

Sudidae Jensen, 1942: 3; Maul, 1945: 3.

DIAGNOSIS: Body compressed, elongate. Belly usually constricted, forming a pro-

FIG. 1. Front of snout of a paralepidid (illustrated from the holotype of *Lestidium prolixum*, n. sp.). The teeth in the emargination of the upper jaw are tohse of the palatines. The premaxillary lacks teeth in this emargination.

nounced mid-ventral carina. Anus moves posteriorly during early ontogeny; finally situated in region of pelvic fins. Eyes moderately large, with adipose lids. Mouth with extensive buccal valves. Rictus well before eye; tip of maxillary not reaching past a vertical from anterior border of eye except in early postlarvae. Symphysis of lower jaw more or less elevated. Corresponding arched, toothless emargination of upper jaw below end of snout (see Fig. 1). Lower jaw included when mouth is closed. Mandibles with 1 to 3 rows of teeth (sometimes atrophied in adults of scaled genera); if present, inner series is composed of depressible canines which recline backward, the outermost series of short fixed teeth of similar shape. Premaxillary closely bound to maxillary and not protractile. Premaxillaries anteriorly with a single row of depressible canines, situated on the inner face of this bone, followed by single series of short fixed teeth on edge of bone. Dorsal process of premaxillary with wide circular foramen in all genera except *Sudis*. Supramaxillary slender, approximately 0.5 length of maxillary. Vomer toothless, or with 1 or 2 tiny teeth. Palatine long and slender, anteriorly attached to sides of mesethmoid and vomer. Teeth on palatines in 1 or 2 rows. Teeth on tongue absent or minute.

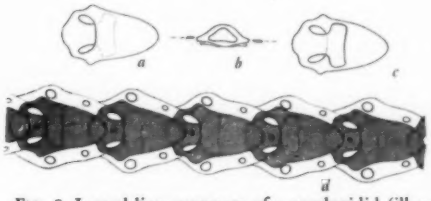

FIG. 2. Lateral-line segments of a paralepidid (illustrated from the holotype of *Lestidium thunnorum*, n. sp.). *a*, Top of an ossified segment: *b*, posterior view of an ossified segment with adjoining pores stippled; *c*, bottom of an ossified segment; *d*, a series of ossified segments in normal position along the lateral-line. The lateral-line scales of the genera *Megalosudis*, *Paralepsis*, and *Notolepis* overlie these ossified segments.

Scales when present cycloid, generally caducous. Lateral-line tube large, imbedded in the skin, enclosed in characteristic partly ossified segments (see Fig. 2), which perhaps are highly modified scales. In the naked genera, the outer shield-like section of each partly ossified segment forms an imbedded scale-like structure. In scaled genera, these structures overlain by lateral-line scales. Tube variously pierced by pores medially, above, and below.

Dorsal fin small, with 9–15 rays, situated near middle of body length. Adipose dorsal fin present over posterior end of anal fin. Anal fin far posterior, with long base and numerous rays (21–50). Caudal fin small, very short and forked, free from adipose and anal

fins, with 18–20 principal rays. Pectoral fins moderately low, below midaxis of body, with 9–17 rays. Pelvic fins small, close together, behind middle of standard length, with 8–12 rays; their position varies from far before dorsal fin to behind dorsal base. Vertebrae 65–102, as far as known. No light organs present.

Secondary sexual dimorphism not known. Specimens have been taken up to approximately 20 inches in length.

Sudis Rafinesque (1810) was the first genus of the barracudinas to be described, but it was indicated as being related to *Sphyraena* and placed in "Esocidi." Cuvier described *Paralepis* in 1817 for two species mentioned by Risso (1810) and also related it to *Sphyraena*. Apparently Bonaparte (1832–46) first elevated one of the genera to familial status when he placed "Paralepidini" as a subfamily of Sphyraenidae (1832–41) and of Scopelidae (1846), using, *ipso facto*, *Paralepis* as the family type. He recognized both *Sudis* and *Paralepis* in this group. As far as I can find, all authors up to the time of Regan (1911) used *Paralepis* as the type genus, with Gill (1874) the first author to raise the group to the status of a full family (Paralepididae). Dollo (1908) and many subsequent authors shortened the name to Paralepidae, but this is not proper form. Regan (1911) based the family name on *Sudis* because it is the oldest generic name. According to the Rules of the International Commission of Zoological Nomenclature as clarified by Opinions 133 and 141, however, this is not acceptable, because Paralepididae was proposed before Sudidae. Unless I have missed a reference earlier than Bonaparte, in which a family name was based on *Sudis*, Paralepididae is the proper name. It seems unlikely that there is an earlier reference, since Bonaparte was apparently the first ichthyologist to use family endings.

Relationships within the Family

Most authors, except Ege, have examined only a few of the genera and usually only very immature material. As a result, few workers have attempted to analyze the major paralepidid relationships. Most current authors have accepted Ege's classification of the family which is based primarily on differences of postlarval development and recognizes only a few generic units. My investigations have primarily stressed the morphological aspects of as mature material as possible although I have utilized several complete ontogenetic series. As there is some important variation between stages of development, it is believed that a clearer picture of paralepidid classification can be obtained by utilizing more than one growth stage.

FIG. 3. Top of head of a paralepidid (illustrated from a paratype of *Lestidium Thunnorum* n. sp.), showing the cranial ridges and the foramina in the premaxillaries.

Although our present knowledge of these fishes is so inadequate as to make very extensive splitting seem premature, certain aggregates of species appear to be so widely separated from their nearest relatives on the evidence of prominent characters in stages older than postlarvae that their inclusion in *Paralepis* seems much too conservative. The retention of only three genera does not allow us to depict several important and easily recognized lines of evolution. In my own investigations, conclusions have been reached which involve a splitting of the genus *Paralepis*, a resurrection of the previously suppressed genera *Les-*

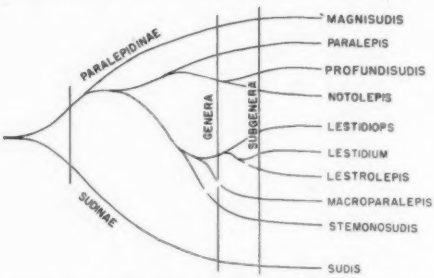

FIG. 4. Diagram of the extent of relationships between the genera of the family Paralepididae.

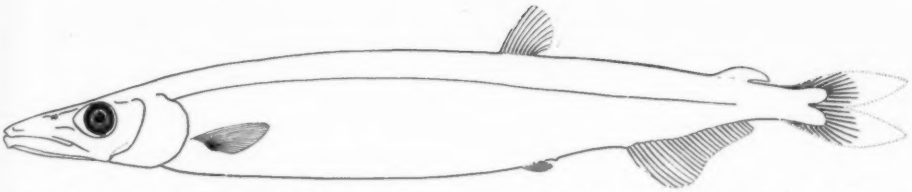

FIG. 5. Genotype of *Magnisudis* (*M. barysoma*, n. sp., paratype, 510 mm. in standard length, from off Lower California).

tidium and *Notolepis*, and the drawing of relationships along lines somewhat different than those given by Ege.

There is no doubt that *Sudis* is unique and remote from the other barracudinas, and there may be some question whether this genus even belongs in the same family with them. *Sudis* is distinguished from all other paralepidids primarily by lack of a foramen in the premaxillary and by other osteological peculiarities, by the unique mandibular dentition, by the reduction of the anterior nostril to a minute pore in adults, by the presence of scales only on the preopercles, and by the different larval development, particularly of the pectoral fins (Ege, 1930: 6). Despite these differences, it is believed that family relationships within the suborder Alepisauroidea can best be shown by retaining *Sudis* in the Paralepididae. The family would then be divided into the subfamilies Paralepidinae and the monotypic Sudinae. The Sudinae most closely resemble the genus *Lestidium* in gillraker structure, lack of body squamation, lateral-line form, and other characters.

The subfamily Paralepidinae falls into two basic generic subdivisions, which are separated in part by the characters given in Ege's key (1930: 7) to separate "Groups I and II" of *Paralepis*. The most obvious differences between the main groupings are that all species in division I are scaled as adults and have numerous teeth in two or more rows on each gillraker and that those of division II are scaleless as adults and have a few teeth in one row on each gillraker. This classification cuts across Ege's system. His groups I and II of *Paralepis* are apparently only remotely related, representing groups of genera that might be designated as tribes (e.g., Paralepidini and Lestidiini).

In determining the relationships within the family, the following characters are probably primitive and apparently trace back into the stock now represented by the Chlorophthalmidae and Aulopidae, the two most generalized families in the order Iniomi: short and massive head; completely scaled body; lack of nonossified prolongation on the lower jaw or snout; large eye far forward; tiny fixed teeth on the jaws, vomer, and palatines; lack of or slight development of an anterior foramen in the premaxillary; hyoid apparatus extending far forward, with gillrakers strongly developed on all five arches; simple lateral-line tube and unmodified lateral-line scales; low number of dorsal and anal rays.

Such characteristics are approached to a remarkable degree by a new species in a new genus, *Magnisudis barysoma*. The conservative *Magnisudis* has a short, broad, massive head and snout, a moderately short, heavy body. The eye is large. The teeth on the jaws are minute; this species is the only paralepidid with teeth on the vomer in the adult. The supramaxillary is free at its posterior end. The gillrakers are reduced to flat bases armed with 4 long filaments (it is of interest that this type of gillraker is unique to *Magnisudis* within the Paralepididae and is known in only one other family of the Iniomi, the Alepisauridae). The gillrakers on the first arches extend far forward on each side of the tongue into the anterior part of the mouth. The tip of the tongue is far forward, near the symphysis of the lower jaw. The lateral-line structure is the

simplest in the family. A single row of large, round, tenaciously adherent scales is present over the lateral-line tube; each scale is pierced by a median pore only. The scales over the remainder of the body are very small, round, and deciduous. The anal fin has comparatively few rays.

Paralepis, which is restricted to a few species, is undoubtedly a derivative of the *Magnisudis* line of evolution. These fishes resemble *Magnisudis* and differ from all the remaining paralepidids in the short, heavy head and body, anteriorly free supramaxillary, long anterior teeth on the gillrakers, and low number of anal rays. The relationship is, however, not really close, since *Paralepis* differs from *Magnisudis* in several important characters. The gillrakers are shorter and more spine-like than in *Magnisudis*, and there are numerous teeth on each raker. Only a few anterior teeth on each gillraker are long, and all the posterior teeth are very short and needle-like. The tongue is long, farther back in the mouth than in *Magnisudis*, and the gillrakers do not extend as far forward on each side of the tongue. The lateral-line structure is more complex. There are one and one-half or two rows of caducous scales over the lateral-line tube. Instead of having but a single median pore, each lateral-line segment is often pierced above and below by another pore. In most species the upper scale row over the lateral line is penetrated near the lower margin by the upper pore, and the lower scale row receives the middle and lower pores, although there is extreme variability in pore structure and a tendency for the reduction in number of pores piercing the lateral-line scales. The body scales are longer than broad, the same size as the lateral-line scales, and extremely caducous. There is little variation within the genus *Paralepis;* except in the case of the inadequately known *P. elongata* Brauer, the species are very closely related and somewhat difficult to tell apart.

The most specialized of the scaled genera is *Notolepis*, which approaches *Lestidium* more closely than any other scaled form. The snout is prolonged and pointed, and the body is more elongate and less deep than in *Paralepis*. The teeth in the adults are not lacking or reduced as in the other scaled genera but are fairly long and well developed. They are distinctly arranged in two or three rows, the outer row of short, fixed teeth, and the inner series of long, hastate, depressible canines. The lateral line is essentially similar in structure to that of *Paralepis* but has more pores; the upper scale row is sometimes peculiarly modified, being notched to receive the large upper pore instead of being pierced by this pore series. The body scales are round, overlapped for most of their length, and are the same size as the lateral-line scales. The teeth on the gillrakers are reduced in length and consist of numerous tiny teeth in oblique rows on each raker. The pharyngeal teeth are reduced in number. It is known from Ege's investigations that the scales tend to form late in life in at least one of the species (*N. rissoi*), and it is very probable that there is a tendency for the suppression of scales in this group. The three species of *Notolepis* are widely separated in distribution: *N. rissoi* from the North Atlantic, *N. coruscans* from the North Pacific, and *N. coatsi* from the Antarctic. The two northern species are much more conservative in form than is *N. coatsi*, which has an extreme development in dentition, gillrakers, and lateral line, and these two species are separated in the new subgenus, *Profundisudis*.

The next evolutionary step appears to involve a greater development of the elongate form and dentition, an important reduction in the number of gillraker teeth, loss of all scales, further specialization of the partly ossified lateral-line segments into characteristic scale-like structures, a wide variability in the position of the pelvic fins in relation to the dorsal fin, and a wide range in the number of anal rays. The most generalized genus of this group is *Lestidium* which corresponds to group II of Ege (1930: 7).

Lestidium can be distinguished from the

genera *Magnisudis*, *Paralepis*, and *Notolepis* by the complete absence of scales, by the greater length of the mandibular teeth, by the arrangement of the teeth on each gillraker into a single row of short needle-like structures, and by the reduction of the pharyngobranchial teeth to a single patch.

The ancestral stock evidently split rather early into three developmental lines. One of these, which can be designated as the subgenus *Lestidiops*, is the most conservative. It is characterized by a somewhat massive head and blunt snout, a deep and heavy mandibular symphysis, the absence of nonossified prolongations on the jaws, a low number of anal rays (26–28), and the position of the dorsal fin in the middle third of the space between pelvic and anal fins.

The second evolutionary line, the subgenus *Lestidium*, comprises the majority of the species from both the Atlantic and the South Pacific. It has retained a relatively low number of anal rays (27–33) but has developed a slightly less massive head and snout and, in the most specialized species, a prominent, nonossified prolongation on the lower jaw (*neles*, *pacificum*, *nudum*). In all members of the subgenus *Lestidium* the position of the dorsal fin is over the pelvic fins. The third evolutionary line of the genus *Lestidium*, which is similar to the subgenus *Lestidiops* in the position of the dorsal fin in the middle third of the distance between the pelvic and anal fins, constitutes a new subgenus, *Lestrolepis*. This clearly delimited group of the genus *Lestidium* is distinguished by a high number of anal rays (33–49), a slender and elongate lower jaw, a distinctive preorbital pigmentation, a well-developed, nonossified prolongation of the lower jaw, and the position of the dorsal fin.

The remaining Paralepididae have been placed by Ege in the genus *Macroparalepis*. He differentiated this group on the basis of four characters, presumed to be unique: (1) the nonossified prolongation on the tip of the lower jaw; (2) the shape of the lateral-line segments, which have the greatest height at or very near the anterior margin; (3) the presence of two pores above and below on each

FIG. 6. Postlarva of *Lestidium sphyraenoides* (Risso), approximately 8 mm. in length, showing the position of the intestine behind the eye (after Ege, 1930).

lateral-line segment; and (4) the position of the intestine under the eye in postlarvae (see Figs. 6 and 7). My investigations show that at least three of these characters are shared by other paralepidids, and it may be questionable that the other is unique to *Macroparalepis*. The subgenera *Lestidium* and *Lestrolepis* both have nonossified prolongations of the lower jaw, and many species of the genus *Lestidium* possess characters 2 and 3. The condition stated for (3) has been found to be the basic pore pattern for all naked genera and is not unique to any particular paralepidid group. In regard to point 4, Ege has stated in correspondence that his groups I and II of "*Paralepsis*" both have the same postlarval development, with the intestine behind the head, differing markedly from that of *Macroparalepis*. No one, however, has been able to examine the postlarvae of the species in *Lestidium* that most closely approach *Macroparalepis*, and there may be some intergradation in these larval characters.

FIG. 7. Postlarva of *Macroparalepis brevis* Ege, approximately 8 mm. in length, showing the position of the intestine below the eye. (This illustration prepared from a tracing generously supplied by Ege.)

Ege considers that *Macroparalepis* is very distinct and that *Lestidium* [*Paralepis* group II] is much more closely related to *Paralepis* [*Paralepis* group I] than it is to *Macroparalepis*. This opinion is based primarily on the differences in postlarval development. My conclusions are entirely the opposite in regard to Ege's *Macroparalepis* group I. In every adult

character, such as in head and body form, prolongation of the lower jaw, dentition, gillrakers, maxillary structure, lateral line, and lack of squamation, *Macroparalepis* group I is very close to *Lestidium* and can be differentiated from this genus only with difficulty. While there may be a consistent difference in the position of the intestine in the postlarvae of these two genera, I doubt that it is of great significance.

Ege divided *Macroparalepis* into two remarkably distinct groups. The first division, which was just discussed, contains four species which have the anus situated behind the origin of the dorsal fin, 13–14 dorsal rays, and 24–28 anal rays. Its high number of dorsal rays surpasses that known for any other form in the Paralepidinae. The dorsum pigment pattern is different from that of all other paralepidids. This group most closely resembles the subgenus *Lestidiops* in general form, anal ray count, position of dorsal fin, and lateral-line form and is probably related to the ancestral stock of this subgenus. It approaches the subgenus *Lestidium* in its nonossified prolongation of the upper jaw. The genus *Macroparalepis* is hereby restricted to Ege's group I (since no genotype has been previously designated).

The second group of Ege's *Macroparalepis*, comprising seven species, is very different from the first. The anus is situated in front of the dorsal fin and there are 9–11 dorsal rays and 37–50 anal rays. The species are very elongate and some even eel-like, the angle of the gape extends back almost to the tip of the maxillary, the tongue is unusually small and far back, the dentition is considerably reduced, and the lower jaw is very slender and pointed with only a slight elevation at its tip. Also, the shape of the lateral-line segments is very different from that found in group I and all other paralepidids, as the length of each segment is twice the height. Despite the fact that groups I and II have similar postlarval development, prolongation of the lower jaw, and pore pattern, their similarities end with these characters. If these similarities to group I are put aside for the moment, group II clearly approaches the subgenus *Lestrolepis* with which it shares the prolongation of the lower jaw, the high number of anal rays, and the same position of the dorsal fin in relation to the pelvic fins. In fact, it may very well be that group II is more closely related to *Lestrolepis* than to group I, and that the similarities to the latter group are due to parallel development or convergence. In any event, group II is far more different from group I than group I is from *Lestidium*, and it is here placed in the genus *Stemonosudis*. A provisional generic tree showing the degree of relationship of the genera as this now appears to me is given in Figure 4.

Comparison of specific paralepidid anatomical structures throughout the family shows some interesting speculative results on the mode of barracudina evolution. In most characters I have examined there is evident a straight-line evolution from the primitive condition in the genus *Magnisudis* to the specialized in *Stemonosudis* through the line of genera as shown in Figure 4. In almost every instance this evolutionary pattern involves a loss or reduction from the form as found in *Magnisudis*. In general, specialization in this family means a loss or reduction in some pre-existing character. Such specialization is exemplified by the gillraker form, which is reduced in the Paralepididae to a flat bony base. This structure is most elaborate in the genus *Magnisudis*, being proportionately large and peculiarly notched. Each raker is armed with 4 long cartilaginous filaments with bony cores arranged in a square. The genus most closely approaching this condition is *Paralepis*. In this group and all remaining genera the rakers are flat and simple in outline. Each raker in *Paralepis* is armed anteriorly with fairly long cartilaginous filaments grading posteriorly into short bony spines. The next step is found in the genus *Notolepis* where all the armature of each gillraker consists of short spines. Thus, we see a trend for the simplification of

the form of the gillraker base, the loss of a cartilaginous sheath from the gillraker spines, and a progressive reduction in the length of these spines. There has been, however, an increase in the number of gillraker teeth. In *Magnisudis* there are 3–4, in *Paralepis* about 5–10, and in *Notolepis* about 15–30 spines on each raker. In all three genera the spines are in two or more rows.

All the rest of the genera in the family (*Lestidium*, *Macroparalepis*, *Stemonosudis*, and *Sudis*) have a singular form of gillraker and gillteeth which is also characteristic of the alepisauroid families Scopelarchidae, Evermanellidae, Omosudidae, and Anotopteridae. It approaches most closely the condition in *Notolepis*. The raker base is considerably reduced in size; the raker spines are very short, similar in form to those of *Notolepis*, but in a single row of 1–7 teeth. There is a tendency for the loss of gillrakers in *Stemonosudis*, as indicated by the fact that they appear to develop later than in other genera.

The degree of similarity of the gillrakers between the varous genera is the same as the composite similarity of important characters and very likely expresses the degree of relationship. If this hypothesis is true, we could expect on the basis of gillraker form that *Magnisudis* and *Paralepis* are more closely related than either is to *Notolepis*. This statement is corroborated by many other characters. For instance, the dentition of *Magnisudis* and *Paralepis* is strikingly reduced and tends to be completely absent in adults. The dentition of *Notolepis*, however, is well developed, not atrophied in adults, and approaches more closely the condition of *Lestidium*. This same balance of relationships is found in supramaxillary form. The supramaxillary in *Paralepis* and *Magnisudis* is strongly arched and widely separated from the maxillary except at its posterior insertion, but in *Notolepis* and all other paralepidid genera it is attached along its entire border to the maxillary. As a result, the genus *Notolepis* is an important link between the scaled and naked genera; in most structures it is most closely related to *Paralepis* and *Magnisudis*, but in some revealing characteristics it is the same as, or similar to, the naked genera, particularly *Lestidium*. Nevertheless, the genus *Notolepis* represents an end point, but in the line of scaled genera evolution. It has an extreme development of dentition (particularly in the subgenus *Notolepis*) and a unique form of lateral-line scales and tube not equaled elsewhere in the family. The genus is somewhat intermediate between *Paralepis* and *Lestidium* but the ancestral stock of the latter genus must have split off rather early from the *Magnisudis-Paralepis-Notolepis* stock. The sharpest break along the evolutionary line of the Paralepidinae as shown in Figure 4 is definitely between *Notolepis* and *Lestidium*, and the impressive differences of *Magnisudis*, *Paralepis*, and *Notolepis* (tribe Paralepidini) from the scaleless genera (tribe Lestidiini) within this subfamily have already been discussed. The scaleless genera of the family have very similar gillrakers, and, as would be expected, all of these genera are closely related on the basis of a large number of characters.

Not all characters, however, follow as simple an evolutionary pattern as the gillrakers. As has already been demonstrated, the lateral-line is a structure of considerable phylogenetic importance but has to be studied carefully because it can be highly variable even among individuals of the same species. In the Paralepididae the simplest form of the lateral-line tube and scales is found in *Magnisudis*, where each segment has a single pore. In *Paralepis* there is usually the addition of a pore above and below in the tube, and in *Notolepis* there are numerous pores in each segment. The most complex pore patterns and lateral-line segment shapes are in the genus *Lestidium*, and there is finally the stabilization of pore number in *Macroparalepis* and *Stemonosudis* to two pores above and two below. While comparison of lateral-line structure among the genera will show that the same degree of relationship exists between the various genera

as illustrated by the gillrakers, there is not a progressive reduction in complexity of lateral-line structure from *Magnisudis*. On the contrary, there is a general increase in complexity of form in the scaled genera from *Magnisudis* through *Paralepis* to the extreme condition found in *Notolepis*. Then there is a progressive reduction in complexity of lateral-line form in the naked genera from the most complex in *Lestidium* through *Macroparalepis* and *Stemonosudis*.

Jensen (1942) has presented the most important discussion on the structure of the lateral-line tube and its overlying scales. However, in some species he has confused the imbedded segments of the tube with overlying lateral-line scales. Therefore, for *Paralepis coregonoides* and *Paralepis brevis*, he figures segments of the lateral-line tube as lateral-line scales. As the scales are so caducous in this genus, the overlying scales were probably missing (see Fig. 11). Jensen points out that the lateral-line scales are extremely variable as to number of pores, which is fully corroborated by the present study.

List of Species Currently Recognized

The following list shows all the known living species of Paralepididae currently recognized in the literature. The synonyms are as given by Ege (1930), Parr (1931*b*), and Maul (1945). No attempt is made to put closely related species together as so many are inadequately known.

Sudis squamosa Chapman (1939: 519) from south of the Aleutian Islands and *Lestidium* (*Bathysudis*) *parri* Chapman (1939: 519) from the Gulf of Alaska do not belong in the family Paralepididae. Hubbs and Chapman (1951) have conclusively identified *Sudis squamosa* as *Mallotus catervarius* (Steller) and *Lestidium parri* as *Thaleichthys pacificus* (Richardson).

Subfamily PARALEPIDINAE Bonaparte, 1846.

Magnisudis, n. gen.

**harysoma*, n. sp. (generic type). Pacific, off California and Mexico.

Paralepis Cuvier, 1817.

**coregonoides* (Risso, 1810) (generic type). North Atlantic.

**speciosa* Bellotti, 1878. Mediterranean.

elongata (Brauer, 1906). Indian Ocean.

**brevis* Zugmayer, 1911. North Atlantic.

**brevirostris* (Parr, 1928). North Atlantic.

bronsoni (Parr, 1928). Bahamas.

danae Ege, 1933. Off Cape Verde, West Africa.

Notolepis Dollo, 1908.

**rissoi* (Bonaparte, 1841). North Atlantic.

**coruscans* (Jordan and Gilbert, 1881). North Pacific.

**coatsi* Dollo, 1908 (generic type). Antarctic.

Lestidium Gilbert, 1905.

sphyraenoides (Risso, 1810). North Atlantic.

intermedium (Poey, 1867). West Indies.

**ringens* (Jordan and Gilbert, 1881). California.

jayakari (Boulenger, 1889). Indian Ocean, off Arabia.

**nudum* Gilbert, 1905 (generic type). Hawaiian Islands, New Zealand (?), Japan (?).

japonicum Tanaka, 1908. Japan.

**sphyraenopsis* (Hubbs, 1916). California.

**pseudosphyraenoides* (Ege, 1918). North Atlantic.

atlanticum (Borodin, 1928). North Atlantic.

thori (Ege, 1930). North Atlantic.

danae (Ege, 1930). North Atlantic.

**affine* (Ege, 1930). North Atlantic.

**pacificum* (Parr, 1931). Pacific off Mexico.

proximum (Ege, 1933). Celebes Sea.

simile (Ege, 1933). Off Cape Verde, West Africa.

luetkeni (Ege, 1933). Mozambique Channel.

bellottii (Ege, 1933). New Guinea.

mirabile (Ege, 1933). Celebes Sea.

**philippinum* (Fowler, 1934). Philippine Islands.

**bathyopteryx* (Fowler, 1944). Pacific, off Mexico.

**vanderbilti* (Fowler, 1944). Caribbean.
**neles*, n. sp. California.
**atrox*, n. sp. Hawaiian Islands.
**thunnorum*, n. sp. Northeastern Pacific.
**prolixum*, n. sp. Japan.
**pofi*, n. sp. Hawaiian Islands.

Macroparalepis Ege, 1933.
**affine* Ege, 1933 (generic type). North Atlantic.
**danae* Ege, 1933. Fiji Islands, Bermuda (?).
**brevis* Ege, 1933. Off St. Helena, North Atlantic.
egei Maul, 1945. Madeira Island, North Atlantic.

Stemonosudis Harry, 1951.
macrura (Ege, 1933). Sumatra.
elegans (Ege, 1933). Lord Howe Island, South Pacific.
miscella (Ege, 1933). Sumatra.
elongata (Ege, 1933). Ceylon.
gracile (Ege, 1933). Straits of Macassar, South Pacific.
**intermedia* (Ege, 1933) (generic type). Caribbean Sea.

Subfamily SUDINAE Regan, 1911.

Sudis Rafinesque, 1810.
**hyalina* Rafinesque, 1810 (generic type). Mediterranean and Madeira.

Distribution of Genera and Species.

The family Paralepididae is one of the largest in the order Iniomi, consisting of 48 known bathypelagic species. It is world-wide in distribution and apparently occurs in large numbers in deep water to a depth of about 4,000 meters. The species are generally wide-ranging. Adult specimens seldom fall into the hands of ichthyologists, and the majority of the adult material has been taken from the stomachs of *Alepisaurus*, tuna, other larger pelagic fishes, and whales. The general form of paralepidids indicates that these are swift-moving voracious fishes. Larger specimens have very rarely been taken by net and apparently never by hook and line. No sexually mature individuals have been reported, and Dr. Bruun informs me that the "Dana" expeditions were not able to find or, at least, to determine the eggs of this family. It is possible that some or most of the species grow to large size and that no sexually mature adults have been obtained.

The best-known group, the genus *Lestidium*, apparently is the only genus whose members come to the surface where adults may be taken by light at night. The range and abundance of the various species of barracudinas are best understood in the North Atlantic and Mediterranean, mainly because of the extensive Danish Oceanographical Expeditions, which obtained the large collections reported on by Ege. No examples have bene recorded from the South Atlantic (excluding the Antarctic), but 20 species are recognized in the North Atlantic. *Sudis hyalina* is apparently fairly common in the Mediterranean and is also known from Madeira.

About half of the known species of the Paralepididae occur in the Pacific Ocean. The northernmost form is a species of *Notolepis* taken off the coast of Washington. Eleven species of *Lestidium* and *Magnisudis harrysoma* are variously recorded in the North Pacific from off Japan, the Philippine Islands, the Hawaiian Islands, Mexico, and California. These species of *Lestidium* (except L. *nudum*, which is apparently known from the Hawaiian Islands, Japan, and New Zealand) are known only from restricted localities. The barracudinas have been collected in the more southerly Pacific in the East Indies and off New Zealand where five species of *Lestidium*, *Macroparalepis danae*, and five species of *Stemonosudis* have been recorded. All the East Indian species are known only from postlarval or juvenile material, except *Lestidium nudum*.

Very little material has been collected from the Indian Ocean, two of the three recorded species being represented by the holotypes only. These forms are *Lestidium luetkeni* from the Mozambique Channel, *L. jayakari* from Muscat, Gulf of Oman and *Paralepis elongata* from the Seychelles Islands, Chagos Archi-

* Species examined in the present study.

pelago, south Ceylon, Bay of Bengal, and Cocos (Cocos Keeling) Islands. The distinction between the Indian and Pacific faunas cannot be sharply defined. *P. elongata*, the only species known from the eastern Indian Ocean, is recorded very near the Pacific. This species apparently has the greatest latitudinal range of all barracudinas, but, considering that Brauer's types are postlarvae ranging from 8–30 mm., there may be more than one species represented. It is expected that more collecting will reveal various species ranging through the Indo-Pacific region.

The distribution of the Paralepididae in the Antarctic is fairly well known. The "Erebus and Terror," "Challenger," "Pourquoi Pas," "Scotia," "Terra Nova," and the B.A.N.Z. (British, Australian, and New Zealand) Antarctic Research Expeditions collected material from this region, but it was composed almost exclusively of larval to juvenile specimens whose relationships and classification were generally not understood by the original describers. Such confusion has resulted in the subsequent identification of these forms, that only one abundant species, *Notolepis coatsi*, of circumpolar distribution, is definitely recognized from the Antarctic.

No species has been recorded from both the Atlantic and Pacific Oceans, although this apparent distinctiveness may be due to a lack of sufficient material and of proper comparison. Dr. Ege is presently examining the relationships and supposed differences between the Atlantic and Pacific species and plans to publish his findings.

Apparently no paralepidids have been recorded from the Arctic Ocean. The distribution of the three species of *Notolepis* in the North Pacific, North Atlantic, and Antarctic gives a good example of bipolar (pantemperate) distribution.

Explanation of Morphological Figures.

Figures 8, 10, 13, 14, 16, 18, 20, and 22 have been prepared in a standard manner to facilitate comparison of some of the more important morphological characters. These drawings are somewhat diagrammatic but are accurate for the characters involved. These figures present the following information:

A: Anterior part of snout. The teeth that are solid black are depressible; the remainder are fixed. The buccal valves and supramaxillary membranes are stippled. The nostrils on the snout and larger pores on the lower jaw are indicated.

B: Lateral aspect of an enlarged section of the fixed teeth on the middle of the premaxillary.

C: The anterior lateral-line segments on the left side. The stippled area represents the weak membranous part of the tube. The area with longitudinal parallel lines delimits the partly ossified center shield in the naked genera (*Lestidium*, *Macroparalepis*, and *Stemonosudis*) and the central row of scales in the scaled genera (*Magnisudis*, *Paralepis*, and *Notolepis*). The dotted lines show the outline of the internal limits of the lateral-line tube. The crossed lines indicate the scales above and below the central lateral-line row. The characteristic pigmentation in the lateral-line region is presented for some of the species.

D: A section of the ceratobranchial of the first arch showing the gillrakers and gill-teeth. The parallel lines indicate the gill arch. The light line over the tips of the teeth shows the mucus line.

E: Dorsal surface of tongue (glossohyal) and anterior portion of first basibranchial. The stippled area represents the fleshy tongue. The glossohyal and basibranchial are indicated by longitudinal parallel lines. The small hooked circles indicate the teeth.

KEY TO GENERA AND SUBGENERA

1. Teeth on mandible large, triangular, strongly compressed, with serrate edges; always present. Anterior process of premaxillary without a foramen. Outer rays of pelvic fins longer than inner rays. (Subfamily SUDINAE, one genus) . . . **Sudis**
   Teeth on mandible slender, basally round, sometimes hastate, but never

serrate; sometimes absent. Anterior process of premaxillary with wide circular foramen. Outer rays of pelvic fins distinctly shorter than inner rays (Subfamily PARALEPIDINAE) 2

2. Teeth on each gillraker in 2 or more rows (Fig. 10D). Two large, separate tooth patches on pharyngobranchials on each side. Teeth on lower jaw comparatively short or (in some adults) missing, their length up to as much as 5 per cent of snout length. Body scaled in adults 3
Teeth on gillrakers in one row (Fig. 16D). One tooth patch on pharyngobranchials. Teeth on lower jaw long, their length 5–11 per cent (generally above 7) of snout length Fig. 16A). Body naked 6

3. Each gillraker with 4 long filaments in 2 rows (Fig. 8D). Gillrakers extending far forward into mouth, beyond angle of gape. Each lateral-line scale tenacious, much larger than surrounding scales, bordered above and below by at least 3 scales (Fig. 8C) . . . . . **Magnisudis**
Each gillraker with many spine-like teeth in numerous series (Fig. 13D, 14D). Anterior limb of gillarches naked; gillrakers not extending forward to angle of gape. Each lateral-line scale caducous, same size as surrounding scales, bordered above and below by single scale (Fig. 10C) 4

4. Teeth on each gillraker not uniform in size, arranged in a bunch, anterior ones long, extending over next raker; posterior teeth short, needle-like (Fig. 10D). Supramaxillary free from maxillary except at posterior insertion (Fig. 10A). Upper jaw terminating slightly before to slightly behind a vertical from anterior border of eye. Nostrils placed one-fourth or more of upper jaw length anterior to posterior tip of maxillary . . . . . **Paralepis**
Teeth on each gillraker very short, subuniform in size, arranged in oblique rows (Fig. 13D). Supramaxillary closely bound to maxillary (Fig. 13A). Upper jaw terminating almost an eye diameter before orbit. Nostrils over posterior tip of maxillary . . . . . **Notolepis** 5

5. Mandible with 3 rows of teeth, each series having approximately 35 canines (Fig. 13A). Palatine with approximately 50 short fixed teeth in single irregular row . . . . . Subgenus **Notolepis**
Mandible with 2 rows of teeth, totaling approximately 25 canines (Fig. 14A). Palatine anteriorly with 3 long, widely spaced, depressible canines accompanied by short fixed teeth; posteriorly 30 or fewer fixed canines in single row . . . . . Subgenus **Profundisudis**

6. Lower jaw fairly massive, blunt, tip distinctly elevated. Nostrils distinctly before a vertical from posterior tip of maxillary (except in *Lestidium neles*). Angle of gape far before posterior tip of maxillary. Pattern of dorsum variable, but without saddle-like blotches 7
Lower jaw very slender, pointed, tip not elevated (Fig. 20A). Nostrils distinctly behind posterior tip of maxillary. Angle of gape near tip of maxillary. Dorsum not evenly pigmented; posteriorly several saddle-like blotches on dorsum, alternating with similar blotches on base of anal fin (Fig. 19) . . . . . **Stemonosudis**

7. Dorsal fin with 9–12 rays. Dorsum lightly and evenly pigmented only part way down to lateral-line (Fig. 15) except in *Lestidium posi*, which is evenly pigmented all over. Lateral-line segments unpigmented or with a few scattered melanophores. Anterior lateral-line segments usually longer than broad. (Fig. 16C) . . . . . **Lestidium,** 8
Dorsal fin with 11–14 rays (usually 13–14). Dorsum heavily pigmented with large melanophores down onto lateral-line scales (particularly posteriorly). Adults with lateral-line segments usually broader than long (Fig. 18C) . . . . . **Macroparalepis**

8. No prominent markings before eye. Anal rays 26–33*. 9
   Prominent round black spot covering vertical finger-like projection immediately before eye. Anal rays 33–49. . . . . Subgenus **Lestrolepis**
9. Origin of dorsal fin more than half a head length behind a vertical of pelvic fins. Anal rays 26–28. . . . . Subgenus **Lestidiops**
   Dorsal fin over or nearly over pelvic fins, origin less than one third of a head length behind pelvic base. Anal rays 28–33. . . . . Subgenus **Lestidium**

Subfamily PARALEPIDINAE

Head and lower jaw moderately large. Pair of large nostrils on each side of snout. Anterior process of premaxillary with large circular foramen. Teeth on mandibles, if present, slender, basally round, sometimes hastate, but never serriform. Dorsal fin with 9–14 (seldom 14) rays. Pectoral fin moderately developed, not proportionately larger in younger stages. Pelvic fins with inner rays distinctly longer than outer rays. Scales, if present, never just restricted to preoperculum.

MAGNISUDIS new genus
Figs. 5, 8, 11*a*

Recently, Dr. Carl L. Hubbs obtained two adults of scaled paralepidids a foot long from the stomachs of marlin and the great blue shark off Lower California. In addition, the California Division of Fish and Game obtained two adults approximately 20 inches long and some smaller examples from California. Not only are these specimens the largest paralepidids known, but they represent the most generalized of the scaled barracudinas and are distinct in many important characters from all known genera.

DIAGNOSIS: Body large and massive, moderately compressed. No carinae. Head large, conical, moderately compressed. Eye larger Pupil small, crescent or half-moon shaped. much smaller than lens. Snout massive. Nostrils well before end of maxillary. Tip of lowe, jaw elevated. Upper jaw terminating well before vertical from anterior border of eye. Supramaxillary long, approximately 0.33–0.5 as long as maxillary, curved and rod-shaped, free from maxillary except at posterior insertion. Teeth on lower jaw sparse or absent; if present very short; all fixed. Teeth on upper jaw very tiny, closely spaced; fixed teeth in saw-like row. Vomer toothless or with single median tooth. Teeth on palatines very short,

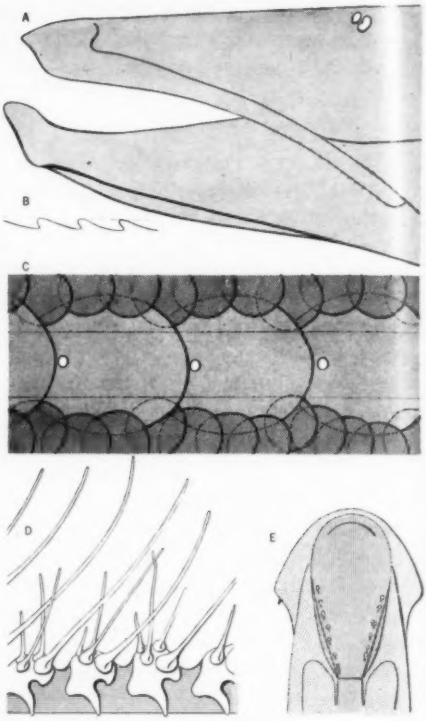

FIG. 8. Genotype of *Magnisudis* (*M. barysoma*, n. sp., paratype, 510 mm. in standard length, from off Lower California). A, Anterior part of snout: B, enlarged section of teeth on middle of premaxillary; C, anterior lateral-line scales; D, gillrakers on first arch; E, dorsal surface of tongue. (See explanation of morphological figures in text.)

* Matsubara's material of "*Lestidium japonicum*" with 35 anal rays (1941: 8) is not included, as it appears to be a new species and the description is not complete enough to place it in a subgenus. Probably it belongs to the subgenus *Lestrolepsis*.

in single row, fixed. Tongue (glossohyal and its fleshy expansion) small and short, but projected far forward near tip of lower jaw. Gillrakers and entire branchial apparatus extending far forward into mouth. Gillrakers well developed on all 5 arches. Each gillraker with 4 long, stiff, cartilaginous, depressible filaments, longest filament 1.5 times greatest pupil diameter. Pharyngobranchial teeth developed in 2 tooth patches on each side. Gill membranes free and separate, joined far forward under vertical from nostrils. Left branchial membrane overlaps right.

Sides of head heavily scaled forward onto preorbital. Occiput covered with scales and lacking tubes or ridges. Body completely scaled. Scales small and moderately adherent, slightly pointed posteriorly and often indented anteriorly, appearing heart-shaped. Scales extending on middle of caudal base for approximately 0.25 its length. Circuli of each scale not continuous except for inner 8 ridges or so; remaining circuli run obliquely off scale. Lateral-line tube fairly small with single median pore on each segment. One row of enlarged, strongly adherent, membranous scales over the tube; each lateral-line scale bordered by 3 or more scales above and below. Body scales much smaller than lateral-line scales.

Pectoral fin with 17 rays. Anal rays 22–25. Dorsal fin origin slightly in advance of pelvic fin origin. Anus behind vertical from dorsal base. Pelvic fins very short, approximately 0.33 length of pectoral fins.

Generic TYPE and only known form, *Magnisudis harysoma* n. sp.

The name *Magnisudis* is formed from *magnus*, L.—large + *sudis*, L.—stake, pile, pike.

The above description will serve to distinguish and demonstrate the relationships of both the genus *Magnisudis* and its single species *M. harysoma*, although the full specific description will appear only in Part 2 of the present study. The holotype of *M. harysoma*, from off southern California, and the paratypes are deposited at Stanford University.

Genus PARALEPIS Cuvier
Figs. 9, 10, 11*b*

Paralepis Cuvier, 1817: xi, 289 (generic type by subsequent designation of Jordan and Evermann, 1917: 104, 120, *Paralepis coregonoides* Risso); Bosc, 1818: 520; Cuvier, 1829: 156; Cuvier and Valenciennes, 1829: 556; Risso, 1826: 472; Günther, 1864: 418; Goode and Bean, 1895: 118; Jordan and Evermann, 1896: 602; Regan, 1911: 127; Jordan and Evermann, 1917: 104; Jordan, 1923: 154; Parr, 1928: 34, 71; Parr, 1929: 29; Ege, 1930: 6; Parr, 1931*a*: 19; Parr, 1931*b*: 152; Whitley, 1937: 11; Maul, 1945: 4; Harry, 1951: 18.

Arctozenus Gill, 1865: 188 (generic type by original designation, *Paralepis borealis* Reinhardt); Goode and Bean, 1895: 516; Jordan and Evermann, 1896: 601; Jordan, 1919: 330; Jordan, 1923: 154; Parr, 1928: 33.

Symproptopterus Cocco, 1885 (no generic type, see Jordan, 1920: 430).

Sudis (in part) Parr, 1928: 34.

Bathysudis Parr, 1928: 41 (generic type by original designation, *Paralepis speciosa* Bellotti); Ege, 1930: 53; Parr, 1931*b*: 153; Gregory, 1933: 207, 209; Gregory and Conrad, 1936: 33; Chapman, 1939: 524.

The author of *Paralepis* has been often given as Risso. However, Cuvier was the first to use the name in a generic sense. According to Whitley, the generic name was introduced strictly in vernacular form (Les Paralepis Cv.) by Cuvier, 1817, and Bosc was the first to latinize it, thus becoming the author of the genus. However, Cuvier listed *Paralepis* as a generic name (*Paralepis* C.) in the "Table Méthodique," and there appears to be no reason for not accepting Cuvier as the author of the genus (see Opinion 39 of the International Commission of Zoological Nomenclature for a similar case involving Cuvier, 1800).

DIAGNOSIS: Body compressed, moderately short and deep. Ventral carina on belly little developed. Head and eye large. Pupil round, larger than lens. Snout short and broad. Nostrils well before end of maxillary. Tip of lower

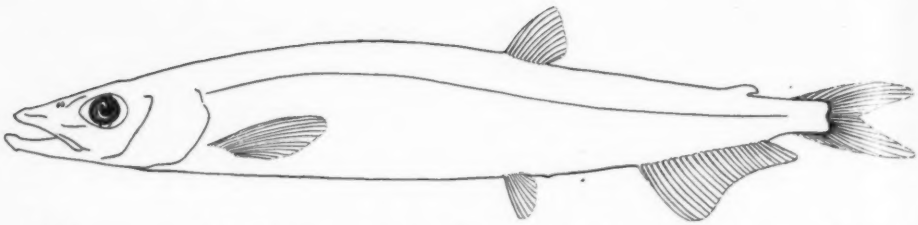

FIG. 9. Representative of *Paralepis* (*P. brevirostris* (Parr), 137 mm. in standard length, from off Medeira).

jaw strongly elevated. Upper jaw reaching to or slightly beyond vertical from anterior border of eye. Supramaxillary long, in adults almost 0.5 as long as maxillary, curved and rod-shaped, free from maxillary except at posterior insertion. Teeth on lower jaw short and weak, tending to be absent in adults. Teeth on palatines short, in 2 irregular rows anteriorly, one row depressible; posteriorly in one row of up to approximately 15 short, fixed teeth. Tongue large, moderately forward in mouth. Gillrakers developed on all 5 arches, not extending forward beyond angle of gape. Gillrakers spinous, anterior teeth on each raker long; posterior teeth very short, needle-like, in numerous rows. Longest rakers as long as pupil diameter. Pharyngobranchial teeth developed in 2 tooth patches on each side. Branchial membranes do not overlap.

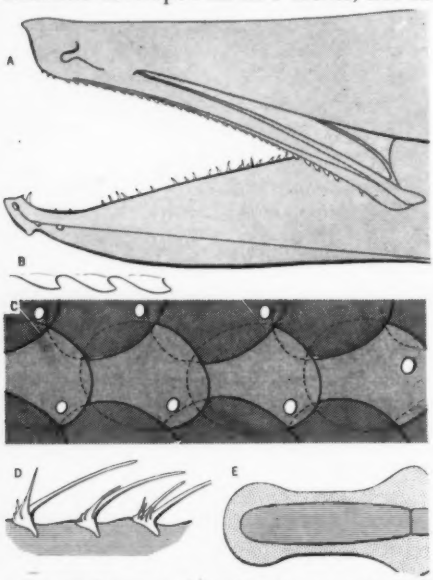

FIG. 10. Genotype of *Paralepis* (*P. coregonoides* Risso, from off Funchal, Madeira, 145 mm. in standard length). A, Anterior part of snout; B, enlarged section of teeth on middle of premaxillary; C, anterior lateral-line scales; D, gillrakers on first arch; E, dorsal surface of tongue. See explanation of morphological figures in text.

Body fully scaled. Scales very deciduous, moderately pointed posteriorly, lacking any indentation on posterior margin. Circuli on scales not continuous except for inner 5 rings or so; remaining circuli run obliquely off the scales (see Fig. 11*b*, and Jensen, 1942: 23, Fig. 9). Lateral-line tube moderately large; 1.5 or 2 scale rows lying over tube. (In the basic pore pattern for this genus the upper scale row over the lateral-line is pierced by the upper pore, and the scale row over the middle of the tube is penetrated by the median and lower pores. There is often reduction in the number of pores piercing the scales.) Body scales same size as lateral-line scales. Pectoral fin rays 14–17. Anal rays 21–26. Vertebrae 67–74.

Disregarding the inadequately known *Paralepis elongata* (Brauer), the genus *Paralepis* could be divided into two subgenera by segregating the generic type, *P. coregonoides*, in the subgenus *Paralepis* and recognizing the remainder of the species in the subgenus *Bathysudis*. I have not done this because these forms are quite similar and closely related. *Paralepis elongata* is distinct in several basic characters from the remaining species of this genus. If it belongs in *Paralepis* it could be readily placed in a new subgenus.

Species I have examined that are undoubted

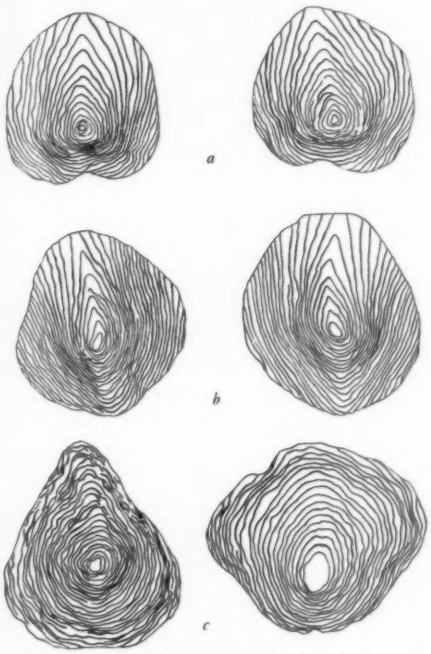

FIG. 11. Scales taken from behind and above the pectoral fins of three genera: *a*, *Magnisudis* (*M. barysoma*, n. sp.); *b*, *Paralepis* (*P. coregonoides* Risso); *c*, *Notolepis* (*N. coatsi* Dollo). (Illustrations prepared from direct projections.)

members of the genus *Paralepis* are: *P. brevis* Zugmayer, *P. brevirostris* (Parr), *P. coregonoides* (Risso), and *P. speciosa* Bellotti. I believe that *P. danae* Ege (1933) and perhaps *P. elongata* (Brauer) also belong here. *P. bronsoni* (Parr) appears to be a synonym of *P. brevirostris* (Parr) (Harry, 1951: 19).

Genus NOTOLEPIS Dollo

Figs. 11*c*, 12, 13, 14

?Prymnothonus Richardson, 1845: 51 (generic type by monotypy, *Prymnothonus hookeri* Richardson); Günther, 1870: 175; Günther, 1889: 39; Dollo, 1904: 8; Dollo, 1908: 35; Fage, 1910: 16; Regan, 1911: 127; Regan, 1913: 233; Regan, 1914: 38; Regan, 1916: 125; Jordan, 1920: 527; Jordan, 1923: 154; Parr, 1928: 33; Norman, 1937: 83.

Notolepis Dollo, 1908: 58 (generic type by monotypy, *Notolepis coatsi* Dollo); Regan, 1911: 127; Regan, 1913: 233; Regan, 1914: 38; Regan, 1916: 125; Jordan, 1920: 527; Jordan, 1923: 154; Parr, 1928: 33; Norman, 1937: 83; Harry, 1951: 26.

Paralepis (in part) Ege, 1930; Maul, 1945: 4.

?Prymnothonoides Whitley and Phillips, 1939: 228 (generic type by original designation, *Prymnothonoides regani* Whitley and Phillips).

Although this genus was very poorly described by Dollo and was based on irrelevant and insignificant characters, it was erected for one of the most distinctive scaled forms of barracudinas. *Notolepis* is resurrected on entirely different characters of both postlarvae and adults.

DIAGNOSIS: Body compressed and elongate. Ventral carina on belly moderately developed. Head and snout long and sharply pointed. Nostrils behind or over posterior tip of maxillary. Eye moderately large. Pupil round or elleptical, larger than lens. Tip of lower jaw moderately elevated. Upper jaw terminating approximately one orbital diameter before eye. Supramaxillary short, splinter-like, closely bound to maxillary. Teeth on lower jaw well developed, in 2 or 3 rows. Teeth on palatines short, in 1 or 2 rows anteriorly; posteriorly in one row of 30–50 teeth. Tongue narrow, well forward in mouth. Gillrakers not extending forward beyond angle of gape; gillrakers spinous, entirely reduced to many rows of short fixed needle-like teeth. Longest rakers much shorter than pupil diameter. Pharyngobran-

FIG. 12. Representative of *Notolepis* (*N. coruscans* Jordan and Gilbert, from the Pacific off Washington, 159 mm. in standard length).

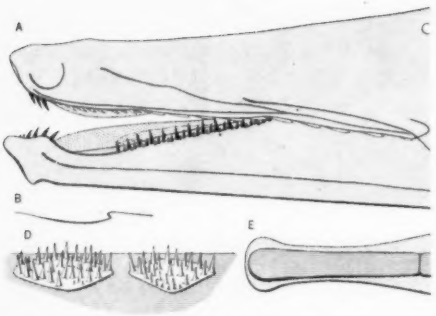

FIG. 13. Genotype of *Notolepis* (*N. coatsi* Dollo, from the Antarctic, 302 mm. in standard length). A, Anterior part of snout; B, enlarged section of teeth on meddle of premaxillary; D, gillrakers on first arch; E, dorsal surface of tongue. (See explanation of morphological figures in text.)

chial teeth developed in 2 patches on each side. Branchial membranes do not overlap.

Body fully scaled. Scales very deciduous, rounded or pointed posteriorly, occasionally with indentation on anterior margin. The circuli are continuous for inner 8 rings or more, outermost rings run obliquely off the scales (see Fig. 11*c*, and Jensen, 1942: 22, Fig. 6). Lateral-line tube large, with at least 1 pore above, medially, and below on each segment; tube covered by 1½ rows of scales. Upper scale row sometimes notched to receive upper pore, as shown in Fig. 14C, or may be pierced by pore series as in *Paralepis*. Lower scale usually penetrated by median and lower pores. Body scales same size as lateral-line scales. Pectoral fin with 11–13 rays. Anal rays 27–34. Vertebrae 78–95.

All three known species of the genus *Notolepis* have been examined. These can be divided into two subgenera as *N. coatsi* Dollo differs markedly from *N. rissoi* (Bonaparte) and *N. coruscans* (Jordan and Gilbert) in several characters.

Subgenus NOTOLEPIS Dollo
Fig. 11*c*, 13

DIAGNOSIS: Mandible with 3 series of teeth, each row with approximately 35 canines. Palatine with approximately 50 short fixed teeth in single row. Each gillraker on ceratobranchial of first arch with approximately 30 short, fixed, needle-like teeth. Apparently, each lateral-line segment with large median-pore at posterior margin and tiny pore above and below near anterior margin. Anal rays 27–29.

This subgenus is monotypic, containing only *Notolepis coatsi* from the Antarctic.

PROFUNDISUDIS new subgenus
Figs. 12, 14

Arctozenus (in part) Jordan and Evermann, 1896: 601.

DIAGNOSIS: Mandible with 2 series of teeth, totaling approximately 25 canines. Palatine anteriorly with long widely spaced depressible canines accompanied by short fixed teeth, posteriorly with 30 or fewer short fixed canines in single row. Each gillraker on ceratobranchial of first arch with approximately 15 short fixed spine-like teeth. Each lateral-line segment with 1 large pore above and another below at posterior margin, with pair of minute

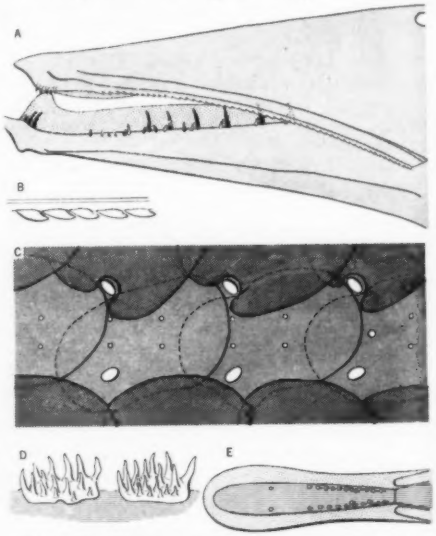

FIG. 14. Representative of the genus *Notolepis* and the new subgenus *Profundisudis* (*N. coruscans* Jordan and Gilbert), from the Pacific off Washington, 159 mm. in standard length). A, Anterior part of snout; B, enlarged section of teeth on middle of premaxillary; C, anterior lateral-line scales; D, gillrakers on first arch; E, dorsal surface of tongue. (See explanation of morphological figures in text.)

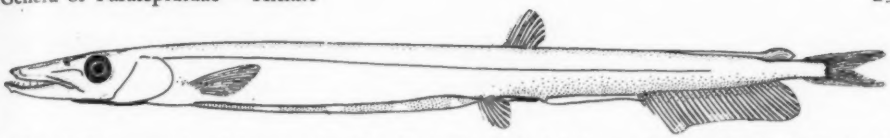

FIG. 15. Representative of the genus *Lestidium* (*L. pacificum* (Parr), holotype, from the Pacific off Mexico, 164 mm. in standard length). This species is closely related to the genotype.

pores between; another pair of minute pores near anterior margin of each section. Anal rays 30–34.

Subgeneric TYPE, *Arctozenus coruscans* Jordan and Gilbert, from the North Pacific. This subgenus also contains *N. rissoi* from the North Atlantic.

The name is formed from *profundus*, L.—of the depths + *sudis*, L.—stake, pile, pike.

Genus LESTIDIUM Gilbert
Figs. 1, 2, 3, 6, 15, 16

Paralepis (in part) Cuvier, 1817: xi, 289; Ege, 1930; Maul, 1945: 4.

Lestidium Gilbert, 1905: 607 (generic type by original designation, *Lestidium nudum* Gilbert); Regan, 1911: 127; Hubbs, 1916: 154; Jordan, 1920: 513; Jordan, 1923: 154; Borodin, 1928: 10; Parr, 1928: 33; Parr, 1929: 29; Parr, 1931*a*: 19; Parr, 1931*b*: 153; Gregory, 1933: 209; Gregory and Conrad, 1936: 33; Ege, 1933: 229; Norman, 1937: 83; Chapman, 1939: 524; Harry, 1951: 26.

Lestidiops Hubbs, 1916: 154 (generic type by original designation, *Lestidiops sphyraenopsis* Hubbs); Jordan, 1920: 559; Parr, 1928: 33; Parr, 1931*a*: 19; Parr, 1931*b*: 153.

This genus is the largest in the family and also the most abundant. Generally it has been taken wherever the family has been recorded. It is best known in the northern hemisphere where the majority of the species have been found. It will probably be found to be abundant also in the Central Pacific, particularly from the region of the Philippine Islands northward to Japan. *Lestidium* is most closely related to the genera *Macroparalepis* and *Stemonosudis* and appears to be the least specialized of these three groups.

Adults are attracted by light at night and can be most readily taken by this means. In fact, Dr. Earl S. Herald and Dr. A. W. Herre have informed me that large examples of *Lestidium philippinum* are found in the fish markets of the Philippine Islands and are taken by the native fishermen with lights.

Gilbert (1905) described *Lestidium* as having "a photophore directed downward and backward at lower orbital margin". This was in error; no paralepidid has any light organ.

DIAGNOSIS: Body compressed, elongate. Ventral carina on belly well developed. Head and snout long, pointed. Eye large. Pupil oval or round, larger than lens. Nostrils before or over posterior tip of maxillary. Tip of lower jaw strongly elevated. Upper jaw terminating at or well before vertical from anterior margin of orbit. Angle of gape well before tip of maxillary. Supramaxillary short, splinter-like, closely bound to maxillary. Teeth on lower jaw long and well developed, with antrorse and retrorse canines. Vomer sometimes with few teeth in young. Teeth on palatines long, in 2 rows anteriorly, 1 row depressible; posteriorly with approximately 5–15 fixed teeth in 1 row. Tongue large, moderately forward in mouth. Gillrakers not extending beyond angle of gape; spinous, with 1 row of short fixed teeth on small base. Pharyngobranchial teeth developed in 1 patch only on each side.

Body and head naked, lacking scales. Lateral-line tube large. Membrane over lateral-line modified into scale-like structures which are highly variable between species. Each lateral-line segment variously pierced above and below by 1 to 5 pores but basic pore pattern of 2 pores above and below. Some forms also with median pore. Greatest height of each lateral-line segment variously at front, middle, and hindmost point. Pectoral fin with 11–13 rays. Dorsal rays 9–12. Anal rays 27–49.

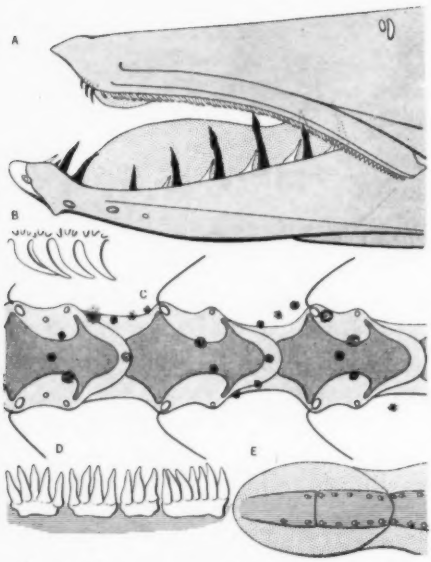

FIG. 16. Representative of the genus *Lestidium* (*L. pacificum* (Parr), holotype, from the Pacific off Mexico, 164 mm. in standard length). A, Anterior part of snout; B, enlarged section of teeth on middle of premaxillary; C, anterior lateral-line segments; D, gillrakers on first arch; E, dorsal surface of tongue. (See explanation of morphological figures in text.)

Vertebrae 77–94, so far as known.

As previously stated, the genus *Lestidium* can be split into three distinct evolutionary lines that may be designated as subgenera.

Subgenus LESTIDIOPS Hubbs

DIAGNOSIS: Head massive. Snout deep and blunt. Tip of lower jaw with 3 vertical nonossified ridges on symphysis, but lacking any prolongations. Eye large, 4.2–5.7 into head. No distinct markings before eye. Dorsal fin behind pelvic fins; distance between dorsal and pelvic fins more than 0.5 length of head. Anal rays 27–28. Each lateral-line segment with 1 to 5 pores (generally 1 or 2) above and below.

This subgenus contains *L. sphyraenopsis* (Hubbs), *L. thunnorum* n. sp., and *L. affine* Ege. All three species have been examined. Subgeneric TYPE, *Lestidiops sphyraenopsis* Hubbs.

Subgenus LESTIDIUM Gilbert

DIAGNOSIS: Head slender. Snout moderately pointed, not deep. Tip of lower jaw with or without nonossified ridges or prolongations. Eye large. No distinct markings before eye. Dorsal fin near or over pelvic fins; distance between dorsal and pelvic fins less than 0.33 length of head. Anal rays 28–33. Each lateral-line segment with 3–5 pores above and below.

Among the species that belong in this subgenus I have examined *L. nudum* Gilbert, *L. pseudosphyraenoides* (Ege), *L. neles* n. sp., *L. pofi* n. sp., *L. prolixum* n. sp., *L. pacificum* (Parr). Other species that apparently belong here: *L. proximum* (Ege), *L. sphyraenoides* (Risso), *L. simile* (Ege), *L. luetkeni* (Ege), *L. mirabile* (Ege), *L. atlanticum* Borodin, *L. jayakari* (Boulenger).

Subgeneric TYPE, *Lestidium nudum* Gilbert.

LESTROLEPIS new subgenus

DIAGNOSIS: Head slender. Snout pointed, not deep. Tip of lower jaw with prominent nonossified prolongation. Eye relatively small, 6.3–7.5 into head. Prominent round black spot immediately before eye. Each lateral-line segment with 3–5 pores above and below. Dorsal fin behind pelvic fins; distance between dorsal and pelvic fins less than 2.5 times into head. Anal rays 35–49.

Subgeneric TYPE, *Paralepis philippinus* Fowler. This subgenus probably also contains *L. japonicum* Tanaka, *L. intermedium* (Poey), and *L. bellottii* (Ege), but only the subgeneric types, *L. vanderbilti* (Fowler), and *L. atrox* n. sp. have been examined.

The name is formed from *lestro*, Gr.—pirate + *lepis*, Gr.—scale.

Genus MACROPARALEPIS Ege
Figs. 7, 17, 18

Macroparalepis Ege, 1933: 229 (generic type not given or subsequently designated; here designated as *Macroparalepis affine* Ege); Maul, 1945: 26; Harry, 1951: 29; Maul, 1952: 51.

This genus is here restricted to group I of *Macroparalepis* as delimited by Ege. Group

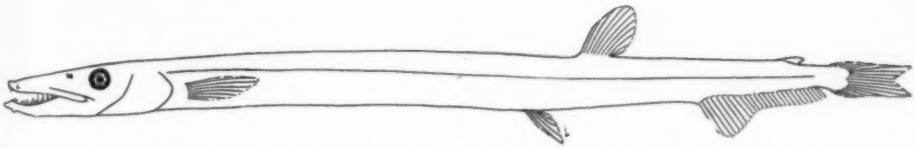

FIG. 17. Genotype of *Macroparalepis* (*M. affine* Ege, from off Madeira, 129 mm. in standard length).

II of Ege's *Macroparalepis* is placed in another genus, *Stemonosudis*.

DIAGNOSIS: Body compressed and elongate. Ventral carina on belly well developed. Head and snout long and pointed. Nostrils before tip of maxillary. Tip of lower jaw strongly elevated. Upper jaw terminating slightly before vertical from anterior margin of orbit. Angle of gape well before tip of maxillary. Supramaxillary short, splinter-like, closely bound to maxillary. Teeth on lower jaw long and well developed, in 2 rows. Teeth on upper jaw well developed antrorse and retrorse canines. Vomer toothless. Teeth on palatines long, in 2 series anteriorly, 1 row depressible; few short teeth in single row posteriorly. Tongue large, moderately forward in mouth. Gillrakers not extending forward beyond anterior border of eye or angle of gape. Gillrakers spinous, with 1 row of short fixed teeth on small base. Pharyngobranchial teeth developed in 1 patch on each side.

Body and head lacking scales. Lateral-line tube large. Membrane over lateral-line modified into large scale-like structures, pierced above and below by 2 pores on each segment. Lateral-line segments partly ossified in double concave form as in *Lestidium*. Greatest height of each lateral-line segment variously at front or hindmost point. Pectoral fin with 10–11 rays. Dorsal rays 11–14. Anal rays 24–28.

I have examined the following species of *Macroparalepis: M. danae* Ege, *M. brevis* Ege, and *M. affine* Ege. The genus also contains *Macroparalepis egei* Maul. Generic type *Macroparalepis affine* Ege.

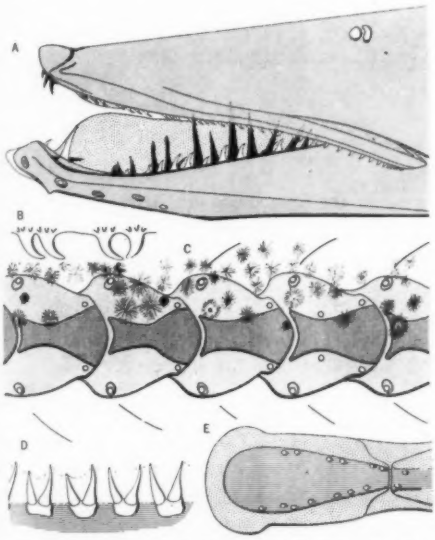

FIG. 18. Genotype of *Macroparalepis* (*M. affine* Ege, from off Madeira, 129 mm. in standard length). A, Anterior part of snout; B, enlarged section of teeth on middle of premaxillary; C, anterior lateral-line segments; D, gillrakers on first arch; E, dorsal surface of tongue. (See explanation of morphological figures in text.)

Genus STEMONOSUDIS Harry
Figs. 19, 20

Macroparalepis (in part) Ege, 1933: 229.
Stemonosudis Harry, 1951: 32 (generic type by original designation *Macroparalepis intermedia* Ege).

DIAGNOSIS: Body slightly compressed and very elongate. Ventral carina on belly moderately developed. Head and snout long and pointed. Nostrils behind posterior tip of maxillary in *Stemonosudis intermedia*. (Dr. Ege examined the types of *Stemonosudis elongata*, *S. gracile*, and *S. intermedia* [his other species of this genus are represented by postlarvae only] and finds them also with the nostrils behind posterior tip of maxillary.) Tip of lower jaw not elevated or only slightly so. Upper jaw terminating approximately 1 orbital diameter

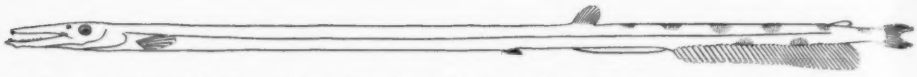

FIG. 19. Genotype of *Stemonosudis* (*S. intermedia* (Ege), from off Bermuda, 125 mm. in standard length).

before anterior margin of eye. Angle of gape near tip of maxillary. Supramaxillary short, thread-like, closely bound to maxillary. Teeth on upper jaw well-developed antrorse and retrorse canines. Vomer toothless. Teeth on palatines short, in 2 rows anteriorly, 1 row depressible; posteriorly few short teeth in single row. Tongue very small, far back in mouth, its anterior tip somewhat near angle of gape. Gillrakers and pharyngobranchial teeth completely undeveloped on material examined. (Dr. Ege informs me that the types of *Stemonosudis elongata*, *S. gracile*, and *S. intermedia* have "gillrakers present on the lower part of the first gill arch, although very small, their length equal to about a fourth of the breadth of the bone of the gill arch.")

Body and head scaleless. Lateral-line tube very large. Membrane over lateral-line tube modified into large scale-like structures pierced above and below by 2 pores on each segment. Greatest height of each lateral-line segment variously at front or hindmost point. Pectoral fin with 10–13 rays. Dorsal rays 9–11. Anal rays 37–50.

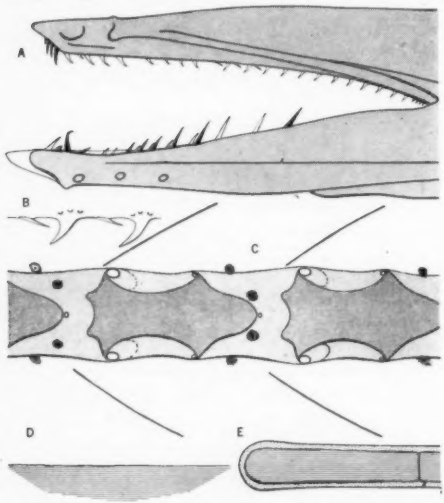

FIG. 20. Genotype of *Stemonosudis* (S. intermedia (Ege), from off Bermuda, 125 mm. in standard length). A, Anterior part of snout; B, enlarged section of teeth on middle of premaxillary; C, anterior lateral-line segments; D, toothless first gill arch; E, dorsal surface of tongue. (See explanation of morphological figures in text.)

Generic TYPE *Stemonosudis intermedia* (Ege). It is presumed that *S. macrura* (Ege), *S. elegans* (Ege), *S. elongata* (Ege), and *S. gracile* (Ege) belong in this genus, although I have been unable to examine any of them. *S. intermedia* is from the West Indies; all other members of the genus are East Indian. Further investigation might show that the East and West Indian forms belong in separate genera or subgenera.

Subfamily SUDINAE

Head and lower jaw very large and massive. Nostrils of equal size in young. Adults with posterior nostril normal, anterior nostril reduced to tiny pore in anterior rim of other nostril. Anterior process of premaxillary without foramen. Teeth on mandible very large, triangular in shape and strongly compressed; edges finely serrate, not accompanied by smaller teeth. Dorsal fin with 14–15 rays. Pelvic fins with outer rays distinctly longer than inner rays. Pectoral fin very long and large, proportionately greatly enlarged in postlarvae and juveniles. Body naked. Head scaled in 2 series on preoperculum.

This group contains a single genus and species, *Sudis hyalina*, known from the Mediterranean and Madeira.

Genus SUDIS Rafinesque Schmaltz
Figs. 21, 22

Sudis Rafinesque Schmaltz, 1810: 60 (generic type by monotypy *Sudis hyalina* Rafinesque Schmaltz); Bonaparte, 1846: 35; Canestrini, 1877: 127; Ege, 1930: 6; Maul, 1945: 33; Harry, 1951: 33.

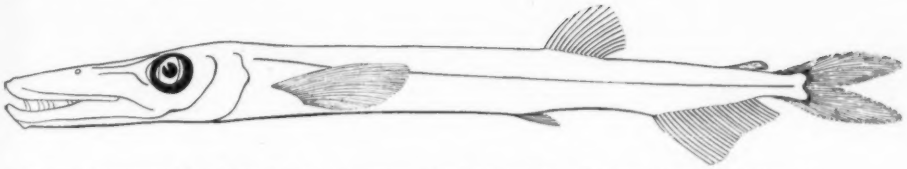

FIG. 21. Genotype of *Sudis* (*S. hyalina* Rafinesque, from off Madeira, 315 mm. in standard length).

Paralepis (in part) Cocco, 1839: 49; Carus, 1893: 566; Sanzo, 1917: 1.
Sudis (in part) Parr, 1928: 34.

DIAGNOSIS: Body compressed and elongate. Ventral carina on belly moderately developed. Head large, strongly compressed. Snout very large and deep. No nonossified prolongations on tip of lower jaw. Nostrils situated almost 0.33 length of maxillary before posterior tip of maxillary. Eye very large. Pupil vertically oval, much larger than lens. Supramaxillary large, more than 0.5 as long as maxillary, splinter-like, closely bound to maxillary. Teeth on lower jaw very large, in 1 or 2 series, of triangular shape and strongly compressed; edges minutely serrate. Few mandibular teeth depressible. Teeth on premaxillary minute, serrate, all fixed. Teeth on palatines moderately reduced, all fixed; anterior teeth in 2 rows with long teeth sometimes accompanied by short ones; anterior double series followed by single series of short or minute teeth. Tongue large, moderately far forward in mouth. Gillrakers tiny, spinous; each raker composed of 2–4 short teeth in single row; rakers not extending forward beyond angle of gape. Pharyngobranchial teeth well developed in single patch on each side.

True scales developed on preoperculum in 2 series. Otherwise body and head scaleless. The lateral-line tube covered by single row of distinct, overlapping, scale-like segments lacking all trace of circuli or annuli. Each segment pierced by 5–8 pores above and below near upper and lower margins. Dorsal fin with 14–16 rays. Vertebrae 59, as far as known.

FOSSIL HISTORY

The order Iniomi first appeared in the Cretaceous, in which the recent families Aulopodidae, Chlorophthalmidae, Myctophidae, and probably Bathypteroidae are clearly evident. The suborder Alepisauroidea (= Paralepidoidea Gill, 1893) appears to be represented in the Cretaceous by the family Ichthyotringidae (new family name to replace Rhinellidae Jordan, 1905, because the monotypic genus *Rhinellus* Agassiz, 1844, is preoccupied; *Ichthyotringa* Cope, 1878, is the next name available), and perhaps the Dercetidae also belong here. *Ichthyotringa* resembles a *Sudis* with an especially prolonged snout. The exact extent of relationships are obscure, however, because the head bones are inadequately known. The Dercetidae, containing perhaps six genera (see the list by Romer, 1945: 584), look remark-

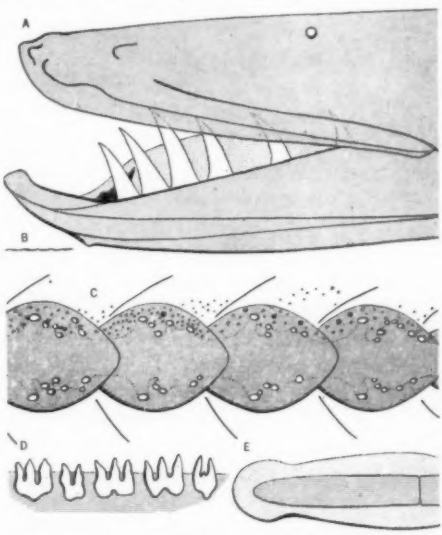

FIG. 22. Genotype of *Sudis* (*S. hyalina* Rafinesque, from off Madeira, 315 mm. in standard length). A, anterior part of snout; B, enlarged section of teeth on middle of premaxillary; C, anterior lateral-line segments; D, gillrakers on first arch; E, dorsal surface of tongue. (See explanation of morphological figures in text.)

ably similar to an elongate paralepidid or anotopterid, but again the head bones are inadequately known, and the resemblance may be only superficial.

The first definite representative of a recent alepisauroid family appears in the Eocene on the basis of the paralepidid genus *Holosteus* Agassiz. *Scopeloides* Wettstein from the Oligocene might be a scopelarchid. A fossil *Alepisaurus* has been discovered in the Miocene of Europe. The genus *Apateodus* Woodward of the Cretaceous family Enchodontidae has a dentition similar to the Alepisauridae, and several authors have suggested a close relationship.

The Paralepididae are the best known inomous group found in the Tertiary, comprising six fossil genera (*Paralepis* Cuvier, *Trossulus* Jordan, *Lestichthys* Jordan, *Drimys* Jordan, *Holosteus* Agassiz, and *Parascopelus* Sauvage) and approximately 10 species. The references to fossil members of the genus *Sudis* belong with *Paralepis*. The paralepidids from the Miocene diatom beds at Lompoc, California, and *Parascopelus* from the Miocene of Europe appear to provide a complete intergradation between this family and the Chlorophthalmidae. Thus it would appear that the suborder Alepisauroidea had not become fully differentiated until relatively recently. This is corroborated by the degree of relationships of the recent forms. The family Paralepididae is distinctly the most generalized group in the suborder Alepisauroidea, and particularly the genus *Magnisudis* shows a revealing number of similarities to chlorophthalmids. The other alepisauroid families (Alepisauridae, Anotopteridae, Scopelarchidae, Evermannellidae, Omosudidae) are much more specialized and probably were well differentiated by the beginning of the Tertiary. The Dercetidae resemble Anotopteridae in which the size of the dorsal fin is between that of the Paralepididae and the Alepisauridae. If there is a relationship here, it indicates that these groups were highly evolved even by the Upper Cretaceous.

Despite the fact that the Miocene fossils seem to show no distinction between the Chlorophthalmidae and Paralepididae, the Eocene, Pliocene, and certain Miocene forms are so similar to recent paralepidid genera that only minor differences are evident in the osteology.

Among recent groups the Paralepididae are most closely related to the Anotopteridae. They both have the same general proportions, essentially similar osteology, the same peculiar cartilaginous development of the jaws which is found in these two families alone in the order, and a good number of other similarities. In turn, the Anotopteridae are very closely related to the highly specialized Alepisauridae. There are secondary modifications of the suspensorium that separate the Anotopteridae from the Alepisauridae, but the cranial osteology and dentition is very similar, the skin has exactly the same pore system in the adults of both families, which is found only in the adults of these two families in the order, and the proportions are closely similar. Therefore, these three families appear to represent one line of evolution arising from a chlorophthalmid-like ancestor, with the Alepisauridae representing the most highly specialized end-point. On the basis of their postlarval development and morphology the Scopelarchidae, Evermannellidae, and Omosudidae appear to have branched off from the alepisaurid line of evolution in various directions and each represents its own unique endpoint of evolution. Among these three families the Scopelarchidae are closest to the Chlorophthalmidae, and the Omosudidae are most closely related to the Alepisauridae.

The Alepisauroidea seems to be a valid suborder despite the fact that at least one of its families (Paralepididae) may have become separated from the Chlorophthalmidae of the suborder Myctophoidea (= Aulopodoidea Gill, 1893) as late as the Miocene or Pliocene. In fact, future research may very well reveal intermediate recent forms between the chlorophthalmid line and the Paralepididae. If this

happens, the retention of the Alepisauroidea should be still justifiable because the greatest phylogenetic break in this suborder is between the Paralepididae and the other families.

The earliest known paralepidid, *Holosteus esocinus* Agassiz (1844: 85, Pl. 43, Fig. 5) appears to be very close to the recent genus *Lestidium* and may actually belong in it. The dorsal fin seems to have been pushed back out of position during fossilization, and it appears from the illustration that it should be approximately equidistant between verticals from the ventral and anal fins.

The most primitive fossil paralepidid seems to be *Drimys defensor* Jordan (1925: 14, Pl. 4b), the clearest intermediate stage yet found between the Chlorophthalmidae and Paralepididae. Unfortunately the only known Miocene fossil is badly crushed. There are 45 vertebrae, a number considerably lower than known for any recent paralepidid. The presence of large, coarsely striated scales is more like a chlorophthalmid, whereas the description of the dentition of the upper jaw is very much like that of a paralepidid.

Trossulus exoletus Jordan (1921: 250, Pls. 8c, 28a) is another Miocene fossil from the Lompoc diatom beds. In general appearance it seems to be a generalized paralepidid with a foreshortened body. It shows closest similarities to *Magnisudis* but actually may be an intermediate form between a chlorophthalmid and a paralepidid. The eye is small, the last dorsal rays are over the anterior anal rays. Of particular significance is the fact that the maxillary is narrow and the premaxillary forms the margin of the upper jaw. There are 50 vertebrae, a number most closely approaching the genera *Paralepis* and *Magnisudis*.

The fossil *Lestichthys porteousi* Jordan (1921: 250, Pls. 10b and 22b) from the Lompoc Miocene diatom beds appears to be very close to the genus *Lestidium*. The vertebral count of 86, proportions, and osteological notes seem to place it in the tribe Lestidiini of the subfamily Paralepidinae.

One of the best known fossils is *Paralepis albyi* Sauvage (= *Paralepis sphekodes*) from the Pliocene. This form is very ably reviewed by Arambourg (1927), who cites the scattered literature and gives sketches of the jaw bones and scapula.

The genus *Parascopelus* Sauvage appears to belong in the Paralepididae near the genus *Sudis*, but the position of the ventral fins far forward is unique in the family.

SUMMARY

The family Paralepididae comprises seven genera (*Paralepis*, *Notolepis*, *Magnisudis*, *Lestidium*, *Macroparalepis*, *Stemonosudis*, *Sudis*) and 48 living species. It is differentiated from all other families of the order Iniomi by a characteristic toothless emargination in the upper jaw below the end of the snout, by a large foramen through the premaxillary in all genera except *Sudis*, by the rictus being well before the eye, and by the position of the dorsal fin which is near the middle of the body length far behind the pectoral fins. The Paralepididae are regarded as most closely related to the Anotopteridae and Alepisauridae of the suborder Alepisauroidea.

The Paralepididae are divided into two subfamilies—the Paralepidinae and Sudinae. The former is characterized by the presence of a foramen in the anterior process of the premaxillary, by slender smooth teeth, by the inner pelvic rays being longer than the outer, and by the pectoral fins remaining small throughout ontogeny. In the Sudinae the premaxillary lacks a foramen, the mandibular teeth are broad and serrate, the outer pelvic rays are longer than the inner rays, and the pectoral fins are greatly prolonged during early postembryonic stages. The subfamily Sudinae is monotypic, containing the genus *Sudis* which is known from the Mediterranean and Madeira.

Evolution in the family generally appears to have progressed by losses of pre-existing characters. This is particularly evident with such structures as squamation, gillteeth, pig-

mentation, and massiveness of form. In this regard the subfamily Paralepidinae has two basic divisions. The members of one division, comprising the genera *Paralepis*, *Magnisudis* (described herein as new), and *Notolepis*, are scaled as adults and have numerous teeth in two or more rows on each gillraker; the genera of the other division (*Lestidium*, *Macroparalepis*, and *Stemonosudis*) are completely scaleless and have few teeth in one row on each gillraker. This classification cuts across the system currently recognized in the literature.

The new genus *Magnisudis* appears to be the most primitive in the family and shows the closest link back to the Chlorophthalmidae and Aulopidae, the most generalized families in the order Iniomi. The genus *Notolepis* has many unique characteristics and represents the end point in scaled genera evolution, approaching more closely the scaleless genera than do either *Paralepis* or *Magnisudis*. The genus *Lestidium* appears to be the most generalized of the scaleless genera and clearly approaches the scaled genera more closely than either *Macroparalepis* or *Stemonosudis*.

The fishes of the family Paralepididae are world-wide in distribution, except for the Arctic. The genus *Notolepis* is bipolar (pantemperate) in distribution. One of its subgenera (*Notolepis*) is known from the Antarctic and the other (*Profundisudis*) occurs in the North Pacific and North Atlantic. Most of the other genera are also wide-ranging.

The suborder Alepisauroidea appears to be represented in the Cretaceous by the family Ichthyotringidae (new name to replace Rhinellidae Jordan, 1905) and perhaps by the Dercetidae. Six fossil genera (*Paralepis* Cuvier, *Trossulus* Jordan, *Lestichthys* Jordan, *Drimys* Jordan, *Holosteus* Agassiz, and *Parascopelus* Sauvage) and approximately 10 species of the Paralepididae are known from the Tertiary. Even as recently as the Miocene there seems to be intergradation between the Chlorophthalmidae and Paralepididae, and as a result the Alepisauroidea became fully differentiated from the suborder Myctophoidea relatively recently.

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NOTES

Faunal Speciation in New Georgia, Solomon Islands

Some 16 years ago the writer made certain contributions to the knowledge of the fauna of San Cristobal, the most eastern of the main Solomon Islands (Lever, *Limn. Soc. London, Proc.* 148(2): 82–83, 1936); this was followed by more general notes on the whole group (Lever, *Trop. Agr.* [Trinidad] 20(2): 40–42, 1943). The purpose of the present paper is to draw attention to an extensive local development of species formation in the New Georgia group of islands lying in the centre of the whole Solomon archipelago.

Besides the main island of New Georgia, which is some 50 miles in length, the group comprises seven closely associated islands including Kolombangara which, though only 15 miles in diameter, rises to a height of over 5,500 feet. All these islands, despite their nearness to one another, are separated by very much deeper water than any other comparable group in Melanesia (Fig. 1). Thus, although Kolombangara is only 10 miles from Gizo, the intervening sea is 245 fathoms deep, and soundings between Rendova and Wana Wana, which are only 12 miles apart, reached 552 fathoms.

Recognition of an inter-insular variation in the animals of these islands was first noted in the birds by Mayr (*Amer. Mus. Novitates* 522: 1–22, 1932), who showed that while the thick-head *Pachycephala pectoralis* is represented by a different species in each of the larger Solomon Islands, in New Georgia alone are several species found. Later he showed that specimens of the white eye, *Zosterops rendovae*, from Vella Lavella and Bagga were distinct from those occurring in Ganongga and Gizo to the south and Kolombangara to the southeast (*Amer. Nat.* 74: 249–278, 1940). In fact the flying time of 3.4 minutes which these small birds take to fly 1.7 kilometers would have enabled them to bridge the gap which however, is sufficient to allow of subspecies occurring on the different islands.

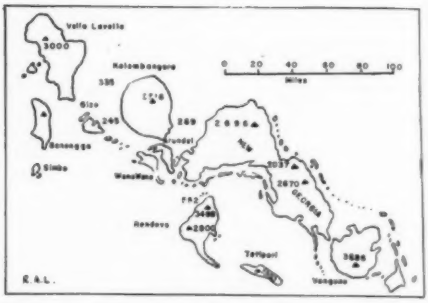

FIG. 1. Map of the New Georgia Group, Solomon Islands. The outlines of this map have been taken largely from United States Army maps, as the most recent official British map (No. 17/30 of Directorate of Colonial Surveys) shows Arundel Island as a portion of New Georgia although in fact a deep-water channel occurs between the former and the intervening Woodford Island, with a constriction at the Diamond Narrows. The D.C.G. map marks, but leaves unnamed, the large island of Vella Lavella; the spot levels have, however, been followed here. The most recent edition (1945) of the British Admiralty chart No. 2392 indicates only tentative outlines for the coast of western Vella Lavella and adds that Gananggo may be 2 to 4 miles further west than its marked position. (Altitude in feet, sea depth in fathoms.)

That this same phenomenon occurs in insects has not heretofore been appreciated. However, well-marked subspecies of the weevil *Exophthalmida coerulescens* Gunther, taken by the writer in 1936, were shown to exist by Marshall (*Roy. Ent. Soc. London, Proc.*, Ser. B. 10(4): 51–55, 1941). The typical form, from Vella Lavella, is opalescent grey with many black spots whereas *E. c. ganongae* is metallic green, and *E. c. kolombangarae* is fawn with small dark spots. A further point of interest

is that, although much more intensive collecting has been done on the more easterly islands of Guadalcanal, Isabel, San Cristobal, and Malaita, this conspicuous metallic weevil was never taken on any of them.

This local endemism, which is probably of relatively recent origin, is not comparable with the inter-insular variation recorded by Marshall (*Roy. Ent. Soc. London, Trans.* 87(3): 69–101, 1938) for another genus of weevils (*Elytrurus*) from Fiji and the New Hebrides or various other insects found in the Marquesas (Mumford and Adamson, *V^e Congr. Internatl. Ent., Paris:* 431–450, 1933), as in these cases the islands are separated by varying but extensive distances of open sea.

Among the Lepidoptera one extreme case of aberration of a bird-winged butterfly can be cited, viz., *Tröides* (*Ornithoptera*) *victoriae rubianus* Roths. Among a series from Ganongga [published as Ranonga], one male had an unusually large green area on the forewing, other males showing a less extensive development (Dicksee, *Roy. Ent. Soc. London, Proc.* 8: 144, 1934). As was remarked when these specimens were exhibited at a meeting of the Royal Entomological Society, it is strange that this Ganongga race should be so very variable as specimens from other islands nearby seemed to be constant in wing pattern. [The distribution of this butterfly is given in Seitz (*Macrolepidoptera of the World*, vol. 9: 12, 1927) as being Kolombangara Island and Rubiana, the latter (also spelled Roviana) being used both for a village on the west of New Georgia and an island lying to the south of the main island.]

Although the bulk of the writer's collections of anisopterous Odonata were wide-ranging forms, a handsome new species taken in 1936, *Agriocnemis salamonis* Lieftinck (*Treubia* 20(2): 319–374, 1949), has recently been described from Ganongga, and it seems likely that adjacent islands will yield more new material from this neglected order.

As few classes of animals have been intensively collected in this area, it is probable that many interesting varieties remain to be discovered although probably not in the Amphibia and Reptilia. These were thoroughly collected and reported on by the Burts (*Amer. Mus. Nat. Hist., Bul.* 63(5): 462–597). Only one snake (*Denisonia woodfordii* (Boul.)) is confined to New Georgia, and it shows no inter-insular variation.

As the writer is no longer stationed in Melanesia, he has thought it desirable to present these few observations and thus draw attention to the intensive endemism to be found in this relatively small but very interesting area.—*R. J. A. W. Lever, Department of Agriculture, Kuala Lumpur, Malaya.*

News Notes

Several meetings of general importance were held in Honolulu during the week of February 16-21.

The American Institute of Biological Sciences' Advisory Panel on Biology to the Office of Naval Research held its spring meeting at the University of Hawaii February 18 and 19. In conjunction with this meeting the Hydrobiology Committee of the A.I.B.S. met at the University on February 20.

The annual meeting of the Invertebrate Consultants Committee for the Pacific, of the Pacific Science Board of the National Research Council, was held at the Experiment Station of the Sugar Planters' Experiment Station, February 18 and 19. L. J. Dumbleton, Plant and Animal Quarantine Officer of the South Pacific Commission, stationed in Noumea, was an observer at the meeting.

Book Notice

EKMAN, SVEN. 1953. *Zoogeography of the Sea.* xiv+417 pp., 121 figs. Sidgwick and Jackson Limited, London. Distributed in the United States by The Macmillan Company, New York. $6.50. A revised English edition of a work originally published in German in 1935.